P. H. Van. Houe, sculp:

P. H. Van Hove sculp:

Thesaurarium Mathematicæ,

OR THE

TREASURY

OF THE

MATHEMATICKS.

Gervas CONTAINING Hamond Jun:

Variety of usefull Practices in *Arithmetick, Geometry, Trigonometry, Astronomy, Geography, Navigation* and *Surveying.*

Linder 94 AS ALSO

The Mensuration of *Board, Glass, Tiling, Paving, Timber, Stone,* and *Irregular Solids.*

LIKEWISE

It teacheth the Art of *Gauging, Dialling, Fortification, Military-Orders,* and *Gunnery:* Explains the *Logarithms, Sines, Tangents* and *Secants:* Sheweth their use in *Arithmetick,* &c. To which is Annexed a Table of 10000 *Logarithms, Log-Sines* and *Log-Tangents.*

Illustrated with several *Mathematical Sculptures* on Copper Plates.

By *JOHN TAYLOR,* Gent.

——*Deus regit Astra; feruntur*
Illius arbitrio Sydera, Terra, Fretum.

LICENSED, *June* 26. 1686. *Rob. Midgley.*

LONDON,
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To the Right Honourable

GEORGE

Lord *DARTMOUTH*,

Master of the Horse to

K. James II.

Master General of His Majesty's Ordnance and Armories, One of His Majesty's most Honourable Privy Council, &c.

This small *Mathematical Treasury* is humbly Dedicated and presented by

My LORD,

Your Honour's most humble

and obedient Servant,

John Taylor.

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THE PREFACE TO THE READER.

HOW *admirably profitable the study of the* Mathematicks *hath been to these* British Islands, *and to all other parts of the* Universe *in which any kind of good Learning hath been esteemed and practised, is well known to all wise and judicious men. And indeed it is an undeniable truth, that among all humane* Arts *and* Sciences *whatsoever, the* Noble Science Mathematical *hath obtained the greatest evidence of certainty, as being the* Queen *of Truth that imposeth nothing on her Subjects but what she proves by most infallible Demonstrations.*

Now this prerogative results from the verity and perspicuity of its Principles, which consist of Definitions, Postulats *and* Axioms. *Hence comes it to pass that all* Propositions *that are proved by those most infallible* Precepts *are called certain*

demonſtrative truths ; for which cauſe i hath been the endeavour of ſundry Philoſophers *to make the force of their Argument (as far as the quality of their diſcourſ would admit) amount unto* Mathematica Demonſtrations, *as being the moſt convin cing proof of a* Propoſition *that by human reaſoning can be given.*

Now having for divers years (amongſt m other Studies) been converſant in the ſtud of the Mathematicks, *and for my own pri vate uſe compiled this Treatiſe, never in th leaſt intending it ſhould have appeared i publick in this* nice *and* critical Age; *bu it by chance falling into the hands of ſom of my* Mathematical Friends *and* Acquaintance, *I have at their requeſts condeſcende to publiſh it , though not without a grea averſion in my own mind to expoſe my ſe in any publick thing.*

But this difficulty being overcome, I ſha give the Impartial Reader *to underſtan that I have faithfully compiled this* Treati *from the beſt of* Authors *(and my own Ex perience) that I have contracted their va rious Works into this little* Cabinet *or choi* Compendium *of the* Mathematicks , *which thou ſhalt find the whole Subject clea ly and intelligibly handled : I have uſed plain and eaſie method : I have laboured*

be as plain and perspicuous as possible: I have applied such Examples to each as may best demonstrate their Operation, be most easie for memory, and applicable to practice; here is indeed Multum in Parvo, *the whole* Marrow *of the* Mathematicks *is in this* Tract *afforded thee, which is as a true and* Golden Key *to unlock the choicest mysteries in those Arts contained.*

Thus, Reader, *I have laid my labours before thee, and must intreat thee to use me as thou wouldst be done by, which is the* Spontaneous *act of every good man.*

But if this shall chance to fall into the hands of any curious conceited person, who thinks himself wiser than the rest of the world, and so he beginneth enviously to carp thereat, and like a Countrey Cur *bark at my backside, to him I shall in modesty onely say,* -----Facilius est unicuivis nostrum aliena curiosè observare: quam propria negotia rectè agere. *'Tis much easier for those* captious Readers *to carp than to copy.*

If the Collections *of* Authors *shall offend any, and so procure the same censure with the* Jackdaw, *as our learned Poet hath long since cautioned against* ------

Ne, si fortè suas repetitum venerit olim
Grex avium plumas, moveat cornicula risum,
Furtivis nudata coloribus.

I would

I would have ſuch contentious Readers *know that I have robbed no man of the honour of his Works, but have given to each his due; only I have borrowed ſome choice things of them, which is no more than what the moſt learned have always done.*

Thus, Courteous *and* Impartial Reader, *'tis only for thee that I have taken theſe pains, and have ſubmitted to the publication hereof, and it is to thee the future parts of my ſtudy ſhall be ſerviceable, hoping that thou wilt find ſucceſs in all thy Studies according to thy deſire and endeavour; which are and ſhall be the hearty wiſhes of him who is*

Thine and *Vrania's*

Servant,

London,
July 12.
1686.

John Taylor.

To the READER.

BEing desired to peruse this *Mathematical Treasury*, accordingly to gratifie the Request of my Friend I did, and I must confess with no small satisfaction to my self to see so much Practical Matter of usefull *Mathematical Arts* so neatly and compendiously digested into this Portable Volume; 'twill be usefull not only to *Learners* and meer *Tyro*'s, but to others also who have made some considerable progress in these Studies. 'Tis well *Methodiz'd*, very *Concise*, yet *Plain* and *Perspicuous*, so that any person of a pregnant fancy, may without a Tutour (in some reasonable time) wade through the whole, or any part thereof, and such as would be more expeditious may take the assistance of a Teacher to instruct them.

The Author is wholly a stranger to me, but to give him his due, in my opinion he has discharg'd himself like a Master in these Arts, and an Ingenious *Mathematician*, to whom I return thanks for this his generous offer in presenting his *Mathematical Treasury* to the Publick, and remain

October 25. 1686.

A true Lover of the Mathematical Sciences, and all such that really delight in those pleasing (but usefull) Speculations,

From my House in *Baldwin's Court* in *Baldwin's Gardens*, over against the Old Hole in the Wall.

Henry Coley.

Courteous Reader,

I Have perused this Treatise, and find that the Author has in every respect discharged himself like an *Artist*; the Work throughout the whole, is very plain and easie, nothing being omitted that might render it Intelligible to the meanest capacity: And indeed, I know not any Treatise of this nature extant that is more Practically handled, so that I doubt not but that it will be very serviceable to the Publick; and that thou in particular mayst find incouragement in the perusal thereof, is the hearty wish of him who is

Thine and Truths Servant,

John Hawkins, *Philomath.*

Octob. 30. 1686.
2 h. 40′ P. M.

To his learned and ingenious Friend Mr. *John Taylor*, in the deserved Praise of his Excellent Book intituled *Thesaurarium Mathematicæ*.

ATlas *and* Hercules *whom* Poets *feign,*
The heavy load of the Earth *to sustain*:
If so? great Toyl and Labour then they took,
Yet not so much as thou hast in thy Book.
Not like to them thy Labours, fictions are,
Thy works so true ingenious and so rare,
That seldom yet such works from man did flow,
For thou by them dost teach us all to know
The secrets of all Sciences and Art,
Which freely unto us thou dost impart.
Thou shew'st us how Numbers to understand,
And how the Speech of Numbers to command.
Geometry, *the Queen of truth, did cease*
The Egyptian *trouble, and did cause a peace;*
When proudly Nile *had overflown their ground,*
And all their Bounds and Land-marks did confound:
By it, each man his proper Right did gain,
And Peace by it great Egypt *did obtain.*
This Art so conspicuous thou hast made,
That to thy Glory it can never fade.
By Sines, Tangents *and* Secants *thou dost show*
Us all the parts of Triangles *to know.*
Thy lofty Genius *viewed the* Stars *on high,*
So that full well thou know'st Astronomy.

All motions of the Sun *and* Planets *thou*
Dost understand, thy works do shew it now.
For thou such Rules and Precepts dost apply,
In this thy Book unto Astronomy;
Demonstrated by rules so rare and plain,
That he's a Dunce *that can't it now obtain.*
Thus having view'd the Spheres *of* Heaven *well,*
Then on our Mother Earth thy Genius *fell.*
Thou view'dst her round, ev'n by inspecting all
The known parts of the Cosometick *Ball.*
And here in this thy Book thou let'st us see,
How Nations *all most disagreeing be.*
The Seaman *he adores thee as his Friend,*
So liberal unto him thy Art doth lend;
And thou from him wilt not thy Talent hide,
Thy Book's a Light-house Mariners to guide.
Surveying *thou dost teach and that so plain,*
That any one that Art may well obtain :
And by that means Injustice to disband,
Attending Lord *and Tenant of the Land.*
To thee the Brooks *and* Springs *do all submit,*
And they will glide to that place thou think'st fit.
Thou shew'st Mechanick *well to apprehend,*
To measure Board *or* Glass, *nay as a Friend,*
Teachest them how both Timber *round and square,*
And Stones *to measure of what kind so e're.*
Therefore to thee they praises still will give,
And tho' thy Body's dead thy Fame shall live.
The Art of Gauging *thou dost plainly teach,*
And farther far than worthy Oughtred *reach*
Into the Mystery of that curious part,
And noble Branch of Mathematick Art.
Thou measurest the course of times short stay,
Thus Dials shew us how time flies away;

That

That thereby we may mind our fading breath,
And preparation make for certain death.
Thy Book's also prepar'd Mars *to withstand,*
In raising Forts *for to defend the Land.*
In ordering Armies *in* Battail aray,
And them Encamping *when they make a stay.*
The Gunner's Magazine *lies in this* Tract,
From whence directions he may have to sack,
Or storm a Town, or batter down a wall,
Or make a Breach *and at the joyfull fall*
Of Turrets *high* Huzza's *to make for joy,*
And entring in, his Enemies destroy.
These curious Arts with more than here are nam'd,
In this rich treasury so neatly fram'd,
Our friendly Authour doth to all impart,
Wishing success, and that with all his Heart.
But stop my Muse *let us not be so rude,*
We'll only wish him well and so conclude.
Maist thou, O Authour of this Treasury,
Reap to thy self profit and praise thereby;
And maist thou ever, ever happy be,
That we more of thy Learned works may see.
Live thou in splendid comfort to thy end,
So prays thy humble Servant, and thy Friend,

July 20.
1686.

Geo. Barrow.

To the Learned Authour my much respected Friend Mr. *John Taylor* on his *Herculean* labours in the Composure of this Excellent Mathematical Treasury.

I *ncrease our Muse, rouze up ye Sisters nine,*
O *n us bestow your Art that we may praise*
H *is works, his worth and his real design;*
N *ot honour vain, but skill aloft to raise.*
Vain Glory's to him but a trifling Toy,
'Tis Art alone, 'Tis that which is his Joy.
[*view'd*
T *he Earth he hath trac'd, the Spheres of Heav'n*
A *nd Star's and Seas whose billows loud do roar;*
Y *et is he not nor can he be so rude,*
L *ike many others to lock up his store,*
O *h he doth not! his Treasure ope' doth stand:*
R *eceive it as a Jewel from his Hand.*
Our noble Friend and Authour what's thy due?
Honour thou slight'st, Treasure's too vain for you.
Thy mind is fixt on Sciences above,
Thou art Urania's *favourite and love.*
Thou know'st her ways, her Art's at thy command,
She smiles upon thee, guides thee by the hand:
For which thy Name we will extoll and praise,
As far as Phœbus *sends his golden raies.*
Therefore in happiness let thy time run,
And rest in Peace when that thy Period's come.

Sept. 27. 1686.

Tho. Robinson.

An *Acrostick* on the Name of my much respected and ingenious Friend Mr. *John Taylor.*

I *f Mathematicks be the Art to teach,*
O *by thy Book the Learned then may reach*
H *eavens Poles, and Circles without doubt or fear,*
N *or to find out each Star it's Hemisphere.*

T *hough* Archimedes *hath much glory got*
A *mongst the* Syracusians, *why not,*
Y *ea Statues be erected to thy Name?*
L *et Eagles wings towre and soar thy fame.*
O *happy maist thou be, and this thy Book*
R *eaders instruct when e're they in it look.*

London, July 29. 1686.

Fran. Pierce.

ADVERTISEMENTS.

Arts and Sciences Mathematical, profess'd and taught by HENRY COLEY, Philomath. *at his House in* Baldwins Court *over against the* Old Hole *in the* Wall, *in* Baldwins Gardens *near* Grays-Inn-Lane.

ARITHMETICK in	Whole Numbers and Vulgar Fractions. Decimal, and by Logarithms.
GEOMETRY.	The Rudiments thereof, also the Demonstration and Practice, according to the best Authours.
ASTRONOMY.	The use of the Globes — Cœlestial, and Terrestrial. To project the Sphere in *Plano* to any Latitude several ways. To calculate the Longitude and Latitude of the Planets, with their Declination and Ascension. Also the true Time, Quantity, and Duration of *Eclipses* of the Luminaries for any time past or to come.
TRIGONOMETRY.	Or the Doctrine and Calculation of Triangles, both — Plain and Spherical. With the Application of the several Cases thereof in the most useful Questions in — Geometry. Astronomy. Geography. Navigation. Dyalling, &c
NAVIGATION.	In either of the three principal kinds of Sayling, *viz.* by the Plain and *Mercator's* Chart, Great Circle.
DYALLING.	Geometrically, Instrumentally, Arithmetically by The Sector, and other convenient Scales. The Logarithms, Sines & [Tan.
SURVEYING.	Several ready ways to measure a Plat, and divide Land, &c. also the taking of Altitudes, Profundities, Distances, &c. together with the Mensuration of all manner of Superficies, as Boards, Glass and Pavement; also all Solids, *viz.* Timber, Stone, &c. Regular and Irregular.
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ASTROLOGY.	In all its parts, and according to the best Authors, with several varieties therein, not known to every Professor.

Non nobis nati sumus.

The Contents.

Arithmetick.

CHAP. I.

Of ARITHMETICK.

ARITHMETICK is an Art of numbring well, for as magnitude, or greatneſs, is the ſubject of *Geometry*, ſo is multitude, or number, that of *Arithmetick*.

Omnia quæcunque à primæva rerum natura conſtructa ſunt, Numerorum videntur ratione formata. Hoc enim fuit principale in animo conditoris exemplar. Boetius *Arith. lib.* 1. *cap.* 2.

I ſhall not in this place trouble you with the firſt Rudiments of Arithmetick, as Numeration, Addition, Subſtraction, Multiplication, and Diviſion: becauſe they are already largely handled by many, as Mr. *Leybourn*, Mr. *Wingate*, and divers others; and alſo that then this Book would ſwell to too big a bulk for the Pocket, and ſo my deſign would be fruſtrated; I ſhall therefore only propoſe and ope-

rate ſome principal Propoſitions, that are of Special moment in Arithmetick, and which moſt immediately concern the other following parts of this Treatiſe.

SECTION I.

§. 1. *The Explication of ſome Arithmetical Propoſitions.*

PROPOSITION I.

To three numbers given, to find a fourth in a Direct proportion.

To operate this proportion Multiply the third term, by the ſecond term, and their product divide by the firſt term, the Quotient ſhall be a fourth term required. *Examp.* 1. Admit the Circumference of a Circle whoſe Diameter is 14 parts be 44 parts, what is the Circumference of that Circle, whoſe Diameter is 21 parts? Now according to the Rule if you multiply the third term 21, by the ſecond term 44, it produceth 924; which divided by the firſt Term 14, the Quotient is 66, and ſo the Circumference of the Circle, whoſe Diameter is 21, will be 66 parts, and ſo for any other in a direct proportion.

PROP.

PROP. II.

To three numbers given, to find a fourth in an Inversed proportion.

To operate this proportion, Multiply the first term, by the second term, and their product divide by the third term, the Quotient is the fourth term required: *Examp.* Admit that 100 Pioneers, be able in 12 hours to cast a Mote of a certain length, breadth, and depth; in what time shall 60 Pioneers do the same? Now if according to the Rule, you Multiply the first term 100, by the second term 12, their product is 1200; which divided by the third term 60, the Quotient is 20, so I say that in 20 hours, 60 Pioneers shall do the same, and so for any other in an Inversed proportion.

PROP. III.

To three numbers given, to find out a fourth in a Duplicate proportion.

The nature of this proposition is to discover the proportion of Lines, to Superficies, and Superficies, to Lines; for like Plains are in a duplicate Ratio; that is as the Quadret of their *Homologal* sides; therefore to Operate any Example in this proportion, Square the third term, and its square multiply by the second Term, their product divide by the square of the first Term, the Quotient is the 4th. term sought; *Examp.* Admit there be two Geometrical squares; now if the side of the grea-

§. 1. ter ſquare be 50 feet, and require 3000 Tiles to pave it; what number ſhall the leſſer ſquare require, whoſe ſide is 30 feet? To operate this according to the Rule, I ſquare the third Term 30, whoſe ſquare is 900: then I multiply it by the ſecond Term 3000, its product is 2700000, which divided by 2500, the ſquare of the firſt Term 50, the Quotient is 1080, and ſo many Tiles will pave the leſſer ſquare, whoſe ſide is 30 feet.

PROP. IV.

To three numbers given, to find a fourth in a Triplicate proportion.

THE nature of this propoſition is to diſcover the proportion of Lines to Solids, and Solids to Lines; for like Solids, are in a Triplicate Ratio, that is to the Cubes, of their Homologal ſides: Therefore to operate any Queſtion in this proportion, Cube the third Term, and his Cube multiply by the ſecond Term, and their product divide by the Cube of the firſt Term; the Quotient is the fourth Term ſought. *Examp.* Admit an Iron Bullet whoſe diameter is 4 Inches, weigh 9 pounds; what is the weight of that Bullet whoſe Diameter is 6 Inches? Now to operate this proportion; firſt according to the Rule I Cube the third Term 6 whoſe Cube is 216, then I multiply its Cube by the ſecond Term 9, the product is, 1944, which divided by 64, the Cube of the firſt Term; the Quotient is 30 $\frac{24}{64}$ pounds which is equal unto 30 *l.* 6 ounces: which is the weight of

of the propounded ſhot; and ſo for any other. §. 1.

PROP. V.

To two numbers given, to find out a third, fourth, fifth, ſixth, &c. Numbers in a continual proportion.

To operate this proportion, you muſt multiply the ſecond number by it ſelf, and that product divide by the firſt Term, the Quotient is a third proportional: Again you muſt multiply the third Term by it ſelf, and its Quadret divide by the ſecond Term, the Quotient is a fourth proportional, and ſo after this manner a fifth, ſixth; or as many more proportionals as you pleaſe may be found: *Examp.* Let it be required to find ſix numbers in a continual proportion to one another; as 4 to 8. To operate this firſt according to the Rule, I multiply the ſecond Term 8 by it ſelf the product is 64, which divided by the firſt Term 4, the Quotient is 16: ſo is 4, 8, and 16 in a continual proportion; And ſo obſerving the Rules preſcribed, proceed in your operation untill you have found your ſix numbers in a continual proportion; which in this Example will be 4, 8, 16, 32, 64, and 128, and ſo will you have form'd ſix numbers in a continual proportion.

§. 1.

PROP. VI.

Between two numbers given, to find out a mean Arithmetical proportional.

THIS proposition might be performed without the help of the rule of proportion: nevertheless because it conduceth to the Resolution of the next ensuing proposition, I insert it in this place; To operate it this is the Rule: add half the difference of the given Terms, to the lesser Term, so that Agragate, is the Arithmetical mean required: *Examp.* Admit 20 and 50 to be the two numbers propounded: Now to operate this proposition, first according to the Rule, I find that the difference of the two given Terms 20, and 50, is 30, whose half is 15, which being added to the lesser Term 20, it makes 35, so is 35, a mean Arithmetical proportion betwixt 20, and 50, given.

PROP. VII.

Between two numbers given, to find out a mean Musical Proportional.

BOETIUS hath this Rule for it, wherefore take his own words: * saith he, " *Differentiam terminorum in minorem terminum multiplica, & post junge terminos, & juxta cum qui inde confectus est; committe illum numerum, qui*

* *In his second Book of his Arithmetick, and the 38 Chapter; where he saith that this proportion hath,* Magnam vim in Musici modulaminis tempera-

" *qui ex differentiis & ter-*
" *mino minore productus*
" *est, cujus cum latitudi-*
" *nem inveneris, addas*
" *eam minori termino, &*
" *quod inde colligitur me-*

mentis,& in Speculatione naturalium quæstionum : *i. e. Great force in Musical composition, (or in the Composure of Musick) and in the discovery of the Secrets of Nature.* §. 1.

" *dium terminum pones.* That is, Multiply the difference of the Terms, by the lesser term,and add likewise the same Terms together :this done if you divide the product, by the sum of the Terms, and to the Quotient thereof, add the lesser Term ; the last Sum is the Musical mean desired : *Examp.* Admit the two numbers given be 6, and 12. I say that if the difference of the Terms which is 6, were Multiplied by the lesser Term 6, it would produce 36 ; then if you add the two terms 6, and 12, together: their sum would be 18, now if you divide 36, by 18, the Quotient is 2 ; lastly if to the Quotient 2, you add the lesser Term 6, the sum thereof will be 8, which is a Mean Musical proportional required.

PROP. VIII.

How to find the Square-Root of any whole number, or Fraction.

Defin. To Extract the Root of any Square number propounded, is to find out another number, which being Multiplied by it self, produceth the Number propounded. Now for the more easie and ready Extraction of the Square-Root of any number given, This Table

§. 1. here under annexed will be usefull; which at first sight giveth all single Square numbers, with their respective Roots.

ROOT.	1	2	3	4	5	6	7	8	9
SQUAR.	1	4	9	16	25	36	49	64	81

The Explication of the Table.

In the uppermost rank of this Table, is placed the respective root of every single Square-number, and in the other the single Square-numbers themselves; so that if the Root of 25 were demanded, the Answer would be 5, so the Square-root of 49, is 7, of 81 is 9; and so for the Rest, and so contrarily the Square of the Root 5 is 25, of 7 is 49, of 9 is 81, *&c.*

Example: If the Square-root of 20736, were required, first they being wrote down in order as you see, draw the Crooked-line, * then to prepare this or any other number for Extraction, make a point over the place of *Unites*; and so on every other figure towards the Left-hand, as you see in the Margent. Then

* *As you use to doe in Division to represent the Quotient.*

Then find the Root of the firſt Square 2, which is 1; place it in the Quotient, and alſo under 2; then draw a line, and ſubſtract 1 from 2, there remains 1; which place under the line, then to the laſt remainder 1, bring down the next Square 07; and then there will be this number 107, which number I call a Reſolvend: Then double the Root in the Quotient 1, whoſe double is 2, which 2 place under the place of tens in the Reſolvend, under 0; ſo is this 2 called a Diviſor; and 10 called a Dividend.

```
 .   .   .
2 0 7 3 6 (1 4 4
1
-------------
1 0 7
  2 4
  9 6
---------------
1 1 1 3 6
    2 8 4
  1 1 3 6
-----------
      0 0
-----------
```

Then demand how often the Diviſor 2, can be had in the Dividend 10, it permitteth but of 4, which place in the Quotient, and under 7 the place of *Unites* in the Reſolvend, and there will appear this number 24; Then Multiply this 24, by 4, (the laſt Square placed in the Quotient) it produceth 96, which place orderly under 24, as you ſee, and this 96 is called a *Ablatitium*; (but ſome calleth it a *Gnomon*:) then draw a line under it, and ſubſtract 96, the *Ablatitium*, out of the Reſolvend 107, there remains 11, which place orderly under the laſt drawn line, then thereunto bring down the next Square 36, ſo will there be a new Reſolvend 1136; then double the whole Root 14 in the Quotient, whoſe double is 28;

place

§. 1. place it under the Resolvend 1136 as was afore directed; so shall 28 be a new Divisor, and 113 be a Dividend; then I find the Divisor 28 can be had in the Dividend 113, 4 times, which four place in the Quotient, and under the place of *Unites* in the Resolvend, so there appeareth this number 284, which number, multiplyed by 4, the last figure in the Quotient, produceth a new *Ablatitium* 1136; which place orderly under the Resolvend 1136, and then draw a line, then substract the *Ablatitium* 1136, from the Resolvend 1136; and the remainder is 00, or nothing: and thus the work of Extraction being finished, I find the Root of the Square number 20736, to be 144; and so must you have proceeded gradually step by step, if the number propounded, had consisted of some 4, 5, 6, or more Squares; still observing the aforegoing Rules and Directions.

NOTE.

BUT when a whole number, hath not a Root exactly expressible by any rational or true Number, then to find the fractional part of the Root very near; To the given whole number annex pairs of Cyphers, as 00, 0000, or 000000, then esteem the whole number, with the Cyphers both annexed thereunto, as one intire whole number: and Extract the Root thereof according to the foregoing Directions, then as many points as were placed over the Integers, so many of the first figures in the Quotient must be taken for Integers; and the remainder for the Roots fractional part in Decimal

cimal parts, and so you may proceed infinitely near the true Root of a Number. §. 1.

To Extract the Square-Root of a Vulgar or Decimal Fraction, and a Mixt-number.

First if the Fraction propounded be not in its least Terms, reduce it, and then by the Rules aforegoing, find the Root of the Numerator for a new Numerator; and of the Denominator for a new Denominator; so shall this new Fraction be the Square-root of the Vulgar Fraction propounded, so the Square-root of $\frac{16}{25}$ is $\frac{4}{5}$.

But many times the Numerator and Denominator of a Vulgar Fraction hath not a perfect Square-root; to find whose Root infinitely near, you must reduce it into a Decimal Fraction, whose Numerator must consist of an equal number of places, to wit, 2, 4, 6, &c. Then Extract the Square-root of that Decimal, as if it were a whole number, and the Root that proceedeth from it is a Decimal Fraction, expressing the Square-root of the Fraction proposed, infinitely near: so the Root of $\frac{13}{16}$ (whose Decimal is, 81250000) will be found to be $\frac{9013}{10000}$ which is very near, for it wanteth not $\frac{1}{10000}$ of an Unite of the exact Square-root, of $\frac{13}{16}$ propounded.

The manner of Extracting the Square-root of a Decimal Fraction.

Now having a Mixt Number propounded whose Root is required, to find which reduce it into an improper Fraction, and then Extract the

The manner of Extracting the Square-root of a Mixt-Number.

Root

§. 1. Root thereof as before. Suppoſe the Number propounded be 75 $\frac{24}{54}$; its improper Fraction is $\frac{679}{9}$, whoſe Square-root I find to be $\frac{26}{3}$, or $8\frac{2}{3}$, very near, *&c.* But if it had not an Exact Square-root, then reduce the Fractional part of the given Mixt-number into a Decimal Fraction, of an even number of places, and then annex this Decimal to the Integers, and ſo Extract the ſame, as a whole number; and obſerve that ſo many points as were ſet over the Integers, ſo many of the firſt figures in the Quotient muſt be eſteemed Integers; and the Remainder for the Roots Fractional part.

PROP. IX.

How to find the Cube-Root of any whole Number, or Fraction.

Defin. To Extract the *Cube-Root* of any Number propounded, is to find out another Number, which being multiplied by it ſelf, and that product by the number again, ſhall produce the number propounded; Now for the more eaſie and ready Extraction of the Cube-root of any number propounded, this Table hereafter annexed will be uſefull, which at firſt ſight giveth the Cube-root of any whole number under 1000; which are called ſingle Cube-numbers.

ROOT.

§. 1.

ROOT.	1	2	3	4	5	6	7	8	9
CUBE.	1.	8	27	64	125	216	343	512	729

The Explication of the Table.

In the uppermoſt rank of the Table is placed the reſpective Roots of every ſingle Cube, and in the other the reſpective ſingle Cube-Numbers; for if the Cube-root of 512 were deſired, the Anſwer would be 8, of 64 is 4; and ſo of the reſt: and if the Cube of the Root 7 were deſired, it would be found 343; of 9 it would be 729, *&c.*

Examp. Admit the Cube-root of the Number 262144, were required, firſt they being wrote down in order as you ſee, draw the Crooked-line.

* Then place a point over the place of Unites, and another over the place of Thouſands; and ſo on ſtill intermitting two places between every adjacent point; and obſerve that as many points, as in that order are placed over any number propounded, of ſo many figures doth the Root conſiſt

* *As you uſe to do in Diviſion, to repreſent the Quotient.*

§. 1.

```
    ·       ·
2 6 2 1 4 4 (6 4
2 1 6
-----------
  4 6 1 4 4
-----------
  1 0 8
      1 8
-----------
  1 0 9 8
-----------
  4 3 2
    2 8 8
        6 4
-----------
  4 6 1 4 4
-----------
        0 0
-----------
```

consist of: so that in this Example, there being two points, therefore the Root consisteth of two places as you see in the Quotient; Now first find the Root of the first Cube 262; which permitteth but of 6, place 6 in the Quotient, and subscribe its Cube 216, under 262, and then draw a line under it, and substract 216, out of 262, and the remainder is 46, which place in order under the last drawn line as you see. Then to the Remainder 46, bring down the next Cube-number 144, so will there appear 46144, which I call a Resolvend: then draw a Line under it, and square the Number in the Quotient 6, whose square is 36; Then Triple it and it will be 108, Then subscribe this Triple square 108, under the Resolvend, so that the place of Unites in the Triple Square 8, may stand under 1 the place of Hundreds in the Resolvend: Then Triple the Root in the Quotient 6, whose Triple is 18, Then subscribe the Triple 18, under the Resolvend, so that the place of Unites 8 in the Triple, may stand under 4 the place of Tens in the Resolvend, and so draw a Line underneath it, and add the Triple Square 108, and the Triple 18 together in such order as they

stand;

ſtand, their Sum is 1098, which may be called a Diviſor, and the whole Reſolvend 46144, except 4 the place of Unites a Dividend ; then draw another line. §. 1.

Then ſeek how many times 1098 the Diviſor, can be had in 4614 the Dividend, it permitteth but of 4, which ſubſcribe in the Quotient ; Now Multiply the Triple ſquare 108, by 4, it produceth 432, which in order ſubſcribe under the Triple ſquare 108: Then ſquare 4, the figure laſt placed in the Quotient, whoſe ſquare is 16 ; and Multiply it by 18 the Triple, it produceth 288, which ſubſcribe under the Triple orderly, then ſubſcribe the Cube of 4 (laſt placed in the Quotient) which is 64, in Order under the Reſolvend. Then draw a line underneath it, then add the three numbers, *viz.* 432, 288, and 64, together in ſuch order as they are placed, their ſum is 46144: Then draw another line under the Work, ſubſtracting the ſaid total 46144, from the Reſolvend 46144, there remains 00, or nothing, which remainder ſubſcribe under the laſt drawn line, thus the work being finiſhed I find the Cube root of 262144 the number propounded, to be 64: And thus you muſt have proceeded orderly ſtep by ſtep, if the number propounded had ariſen to ſome 3, 4, 8, 10, or more places, obſerving the direction preſcribed untill all had been compleated.

NOTE.

BUT when a whole number, hath not a Cube-root expreſſible by any true or Rational number,

number, then to proceed infinitely near the Exact truth annex to the number Tenaries of Cyphers as 000, 000000, 000000000, &c. then esteeming the whole number with the Cyphers annexed as one intire whole Number, Extract the root thereof, as is afore taught. Then as many points as were placed over the Whole Number, so many places of Integers will there be in the Root, and the rest expresseth the Root his Fractional part very near.

To Extract the Cube-Root, of any Vulgar or Decimal or Mixt Fraction consisting of a Whole Number and a Fraction.

To Extract the Cube-root of any Vulgar Fraction, you must first reduce it into his least terms, and then according to the former directions Extract the Cube-root of the Numerator, the Root found shall be a new Numerator; so likewise the Root of the Denominator shall become a new Denominator; so shall this new Fraction be the Cube-root of the Fraction propounded, so I find the Cube-root of $\frac{8}{125}$ to be $\frac{2}{5}$, and so for any other Vulgar Fraction.

The manner of Extracting the Cube-Root of a Decimal Fraction.

But many times the Numerator, and Denominator, hath not a true Root: Then to find the Root thereof infinitely near, you must reduce the Fraction given, into a Decimal, whose numerator is Tenaries of places, and then Extract the Root according to the former Directions, so shall the Root found, be a Decimal Fraction expressing near the Cube-root of the Fraction

Fraction propounded, so I find the Root of $\frac{8}{12}$ or $\frac{2}{3}$, whose Decimal is, 666666666, to be, $\frac{873}{1000}$ very near the Root of $\frac{8}{12}$ or $\frac{2}{3}$ propounded. § 1.

The manner of Extracting the Cube-Root of a Mixt-number.

Now having a Mixt-number propounded, whose Root is required, first reduce it into an Improper Fraction, and then Extract the Cube-root thereof, as is afore directed, so the Cube-root of 12 $\frac{19}{27}$, Improper $\frac{343}{27}$, will be found to be $\frac{7}{3}$ or 2 $\frac{1}{3}$.

But if it hath not an Exact Cube root, Then Reduce the Fractional part of the given Mixt-number into a Decimal Fraction, which shall consist of Tenaries of places, Then to the whole number annex the Decimal Fraction, and Extract the Cube-root of the Whole, and observe that so many points as are over the Integers, so many of the first places in the Quotient must be Esteemed Integers, and the rest Expresseth the Fractional part of the Root in Decimal parts of a Fraction, so the Cube-root of 2 $\frac{3}{8}$, Decimal 2, 375000000 *&c.* will be found to be 1, 334, or 1 $\frac{334}{1000}$, and is very near the true Root, and so for any other Mixt-number of this nature.

CHAP. II.

The Explication, and use of the Tables of LOGARITHMS.

§. 1. SECT. I.

The Explication of the Tables of the Logarithms, and of parts proportional.

Defin. THE *Logarithms*, were first invented, found out and framed, by that never to be forgotten and thrice Honourable Lord, the Lord *Nepeir*: which Numbers, so found out and framed by his diligent industry, he was pleased to call *Logarithms*; which in the Greek signifies the Speech of Numbers, I shall not here trouble you with the manner of the Construction of those Tables of *Logarithms*, but shall first lay down some brief and general Rules, that thereby the better you may Understand those Tables, and then I shall explain their manifold uses, in sundry Examples Arithmetical, &c.

PROP-

PROP. I.

Any Number given under 10000, *or* 100000, *to find the Logarithm corresponding thereunto.*

1. If the number propounded consist of one place whose Logarithm is required to be found, as suppose (5,) look for 5, in the top of the left hand Column under the Letter * *N*, and right against 5, and in the next Column under *LOG.* * you will find this number or rank of figures, 0698970, which is the Logarithm of the number 5 required. §. 1.

* *Signifies the Number, or figure sought.*
* *Signifies the Logarithm answering to the number Opposite.*

2. If the number consisteth of two places as if it were 57, look 57 under *N*, and opposite to it and under *LOG.* you will find this number 1 755875, which is the Logarithm of 57, the number propounded.

3. If the number propounded consist of three places as 972, look for 972, under *N*, and opposite to 972, and under 0) the Column, you shall find this number 2. 987666, which is the Logarithm of 972, the number which was propounded.

4. But if the number consist of four places as 1685, look the three first figures 168, under the Column *N*, and opposite to that, and under 5 at the top of the page, you will find this number 3. 226599, which is the Logarithm of 1685, the number propounded.

§. 1. ☞ *Note this Rule well, for this explains the use of the Table of proportional parts, printed at the end of this Book.*

5. But if the number given be above 10000, and under 100000, you may find its Logarithm by the Table of parts proportional, printed at the latter end of this Book. Thus if the Logarithm of 35786, be sought, first seek the Log. of 3578, which will be 553649, and the common Difference under D is 121; with this difference 121, Enter the Table of parts proportional, and finding 121 in the first Column under D, you may then lineally under 6, find the number 72, which add to the Log. of 3578, that is 553649, it produceth, 553712, which is the Log. of 35786 the number propounded: now because the number propounded 35786, ariseth to the place of *X. M.* therefore there must be the figure 4 prefixed before its Logarithm, and then it will be thus 4, 553712, which 4, is called the Index, as shall be hereafter shewed.

Now before we proceed to find numbers corresponding to Logarithms, it will be necessary to explain the meaning of the first figure to the left hand of any Logarithm placed, Mr. *Briggs* calleth it a Characteristick or Index, which doth represent the distance of any the first figure of any whole number from Unity, whose Index is 0, a Cypher; so the Index of 10 is 1, and so to 100 whose Index is 2, and so to 1000 whose Index is 3, and so to 10000 whose Index is 4, and so if you persist further the Characteristick is always one less in dignity, than

Definition. *The Rule to find the Characteristick or Index appertaining to any Logarithm.*

than the places or figures of the number pro- §. 1.
pounded.

PROP. II.

To find the Logarithm belonging to a Vulgar Fraction, and a Mixt number.

First as is before ſhewed if it be a Vulgar Fraction, find the Log. of the Numerator, and the Log: of the Denominator, then ſubſtract the Log: of the Numerator, from the Log: of the Denominator, the remainder is the Log: of the Fraction propounded: Now if you would find the Logarithm of $\frac{5}{7}$, do as is preſcribed whoſe Log. I find to be 0. 146121, Now to find the Log. of a Mixt Number, reduce it into an Improper Fraction, and then do as before, ſo the Log of $15\frac{2}{5}$, Improper $\frac{77}{5}$, is 1,187,52, and ſo do for any other Mixt number.

The Log: 7 is	0. 84509
The Log: 5 is	0. 69897
The Log: $\frac{5}{7}$ is	0. 14612

PROP III.

A Logarithm propounded to find the whole, or Mixt number, correſponding thereunto.

For the more ſpeedy finding the number, anſwering unto the Logarithm propounded, obſerve that if the Index be 0, then the Number ſought may be found between 1 and 10; If 1,

 between

§. 1. between 10 and 100; if 2, between 100, and 1000; if 3 between 1000 and 10000, and ſo on ſtill obſerving the Rules of the Characteriſtick, or Index, therefore look in the Table untill you find the Logarithm propoſed, and againſt it in the Margent according to the aforegoing directions under *N*, you ſhall find the number belonging thereunto. This Rule holds in force in Mixt Numbers alſo.

Thus.	0. 845098	Are the Logarithms of;	7
	1. 556302		36
	2. 130334		135
	3. 980276		9556

NOTE.

But if you cannot find the Logarithm exactly in the Table, as in many operations it ſo hapneth, you muſt then take the neareſt Logarithm Number to the Logarithm propounded, and ſo take the number belonging thereto for the deſired number.

SECT.

SECT. II. §. 2.

Of the Admirable use of the Logarithms in Arithmetick.

PROP. I.

To Multiply one number by another.

Admit 90, be to be multiplied by 42, what is the product? To find which first find the Log. of the Multiplicand 90, whose Log. is 1. 95424 : Then find the Log. of the Multiplier 42, whose Log: is 1 62324, then add these two Log : together,

The Log : of 90 is—	1. 95424
The Log : of 42 is—	1. 62324
The Log : 3780 is—	3. 57748

viz. the Log : of the Multiplicand, and Multiplier, their sum is 3, 57748, which is the Log: of 3780, the product of 90 ; and 42, Multiplied together.

PROP. II.

To Divide one number by another.

Admit the Dividend (or number to be divided) be 648, and the Divisor 72, what is the number that the Quotient shall consist off? To find which, first write down the Logarithm of the Dividend 648, which is 2. 81157 and al-

§. 2. ſo write down the Logarithm of the Diviſor 72, which is 1. 85733. Now ſubſtract the Log: of the Diviſor, out of the Log: of the Dividend,

The Log: of 648 is	—2. 81157
The Log: of 72 is	—1. 85733
The Log: of 9 is	—0. 95424

the remainder is 0. 95424, which is the Logarithm of 9, ſo I conclude that the Diviſor 72, is contained in the Dividend 648, 9 times, and ſo do for any other.

PROP. III.

To find the Square-Root of a Number.

Admit it be required to Extract the Square-Root of the Number 144, to perform which firſt write down the Log: of 144 which is 2. 15836. Then take the half thereof which is 1. 07918 which number 1. 07918, is the Log: of 12, the Root of 144 propounded, and ſo do for any other.

NOTE.

Now on the Contrary by doubling the Log. of any number, you have the Geometrical Square thereof.

PROP.

§. 2.

PROP. IV.

To find the Cube Root of any Number.

Admit it be required to Extract the Cube Root of 1728, to perform which, First write down the Log. of 1728 which is 3. 23754, then take the third part thereof which is 1. 07918, which is the Log. of 12, which is the Cube-root of the Number propounded 1728, and so for any other. Note on the contrary if you multiply the Log. of any Number propounded by 3, it produceth the Log. of the Cube thereof.

PROP. V.

A Summ of Money being forborn for any number of years, to find how much it will amount unto, reckoning Interest on Interest, according to any Rate propounded.

Admit 300 pounds Sterling, be put out for 4 years, for Compound Interest at 6 *l.* per Cent. what will it amount to when the four years are expired? To find which substract the Log of 300 *l.* the principal, whose Log. is 2. 477121, out of the Log. of 318 *l.* Principal and Interest for a year whose Log. is 2. 502427, the remainder is 0. 025306, which being multiplyed by 4, the number of years of its continuance, produceth 0. 101224, which added to the Log. of the principal 300*l.* to wit, to 2. 477121, makes 2, 578345, which is the Log. of 378 *l.* 14 *s.* 10 *d.* 2 *q.* very near, and so much will 300 *l.* amount to.

PROP.

PROP. VI.

A Summ of Money being to be paid hereafter, to find what it is worth in ready Money.

§. 2. Admit 100 pounds Sterling, to be paid at 30 years end; I demand how much it is worth in ready Money? after the rate of Interest of 6 *l. per Cent.* To find which substract the Logarithm of 100 the principal, whose Log. is 2.000000 from the Log. of 106 Principal and Interest, whose Log. is 2.025306, the remainder is 0 025306, which Multiplyed by 30 the number of years to succeed, produceth 0.759180, which substracted out of 2 000000, leaveth 1.240820, which is the Log. of $17\frac{411}{1000}$, which sheweth the said 100 *l.* is worth but 17 *l.* 8*s.* 2*d* 3*q.* *fere.*

PROP. VII.

A yearly rent, or Annuity to continue any number of years, to find what it is worth in ready Money, at any Rate of Interest propounded.

What is 100 pound *per annum* to continue 30 years, worth in ready money at 6 *l. per Cent.* To find which first substract the Log of 100 *l.* the principal, which is 2.000000 from the Log. of 106 *l* principal and interest for a year, whose Log. is 2 025306 the remainder is 0.025306: Then Multiply 0.025306, by 30 the number of years of its continuance, it produceth the number 0. 759180; Then Divide 100 *l.* by 6 the

the rate of interest and the Quotient is 16 $\frac{6667}{10000}$, §. 2.
&c. which : 16 $\frac{6667}{10000}$, is the proportional parts of 100 *l.* the principal, then add the Log thereof which is 1. 221829 to the former Log. 0. 759180 it produceth 1.981009, which is the Log. of 95 $\frac{7215}{10000}$ parts the Arrearages with the said some for that Time, then from those Arrearages 95 $\frac{7215}{10000}$, substract the parts proportional of 100, to wit 16 $\frac{6667}{10000}$, the remainder is 79 $\frac{0548}{10000}$, which is the bare Arrearages for that proportional part ; Then take the Log. of 79 $\frac{0548}{10000}$, which is 1. 897929, out of the which take the Log. found by Multiplication of years, to wit 0. 759180, there remains 1. 138749, which is the Log. of the value of the Arrearages in ready money, Then to the Log. 1. 138749, add the Log. of 100 *l.* principal, 2. 000000, it produceth this number 3. 138749 ; the Log. of 137 6 $\frac{48}{100}$, reduced is 1376 *l.* 9. *sh.* 7*d.* $\frac{80}{100}$ or $\frac{4}{5}$ *fere* : and so much is the said Annuity worth in ready money.

CHAP.

CHAP. III.

The Explication of the SINES, TANGENTS, *and* SECANTS.

SECT. I.

Of Right Signs, Tangents, Secants, Cosines, Tangents, and Secants: Of any Arch, or Angle of a Triangle.

PROP. I.

To find the right Sine, or Tangent of any Arch or Angle of a Triangle containing any number of Degrees and Minutes.

§. 1. ☞ *And here'tis necessary to understand, that every Circle is supposed to be divided into* 360 *E-*

IF the Angle or Arch of the Triangle propounded be less than 45 Deg. the Sine, or

or Tangent belonging thereunto, is found in the Column under the Title SINE, or TANGENT, at the top of the Table; and if there be any Minutes annexed unto the Degrees, you must find them out in the first Column under M. signifying Minutes, and opposite to those Minutes, and under the title aforesaid, you shall have the Logarithm of the Sine or Tangent, of the Arch or Angle required.

qual parts which are called Degrees, and every of those Degrees into 60 Minutes, and every Minute into 60 Seconds, and every Second into 60 Thirds, &c. so that a Semi-Circle contains 180 Degrees, and a Quadrant 90 Degrees; Now an Arch or Angle of a Triangle, is the Intersection of its two sides, and the measure thereof, is an Arch of a Circle, which cutteth each of the two sides equidistant from the Angular point, (which is the Center.) Now the Logarithm Sine, or Tang. of any such Arch of a Triangle, containing any Number of Degrees or Minutes of the Quadrant, may be found in the Tables, printed at the End of this Book, where they are plainly expressed, and are found as directed in the precedent Rules. §. 1.

But if the Arch or Angle of a Triangle exceed 45 Degrees, you must then look for the Sine or Tangent belonging thereunto, in the bottom of the said Table, and if thereunto are Minutes annexed, you must look for them in the first Column to the Right-hand under M. and so opposite to those Minutes in the Column above the Title, Sine, or Tang; there have you the Log. of the Sine, or Tangent, of the Arch or Angle, of the Triangle propounded.

Examp.

§. 1. *Examp.* Suppose it were required to find the Log-Sine or Log-Tangent; of an Angle of 25 D. 37 M. whose Log Sine, whereof according to the former directions I find to be 9. 635833. and Tangent thereof to be 9. 680768. and so for any other under 45 degrees.

Again, suppose it were required to find the Log Sine or Log-Tangent, of an Angle of 64 D. 23 M. the Sine whereof, I find to be this number 9, 955065, and the Tangent thereof, 10. 319231, and so for any other Arch, or Angle of a Triangle, above 45 degrees.

PROP. II.

To find the Co-Sine or Co-Tangent of any Arch, or Angle propounded.

Defin. The Co sine or Co tangent, of an Angle or Arch, is the remaining part of the Angle propounded, to a Quadrent or 90 Degrees; and is by some called the Complement of an Angle, thus the Arch or Angle of 64 D. 23 M. taken out of 90 D. leaves 25 D. 37 M. for its Complement, on the contrary if 25 D. 37 M. were taken out of 90 Degrees, there would remain 64 D. 23 M. for its Complement. So you see that these two Angles, are the Complements of each other, because they two are equal to a Quadrent or 90 Degrees.

Now the Logarithm of the Complement, may be exactly found with ease, for the Sines and Tangents of every degree, and Minute of the Quadrent in one Column is joyned with his Complement in the next Column, so that with-

without ſubſtracting the Angle from 90 D. you may readily find the Complement thereof either the Arch in Degrees and Minutes, or the Log. Sine, or Tangent thereof, as you have occaſion: Thus the Log. of the Sines Complement before mentioned, to wit, 64 D. 23 M. Comp. is 25 D. 37 M. is 9. 635833, Tang. is 9. 680768; ſo 64 D. 23 M. is the others Compl. whoſe Sine is 9. 955065, and his Tang. is 10, 319231; ſo for any other. §. 1.

PROP. III.

To find the Secant of any Arch or Angle propounded.

In this little Book I have not room to ſet down the Tables of Artificial Secants at large, as I have done with the Sines and Tangents: Nevertheleſs I will not here omit to ſhew how they may be eaſily found out, by the Tables of Sines. The method is thus, ſubſtract the Logarithm Sine, of the Sines compl of an Angle, from the double *Radius* of the Tables, and the remainder ſhall be the Secant required: As if I deſire the Secant of 25 D. 37 M. I find the Logarithm ſine of his complement to be 9. 955065, which ſubſtracted from the double *Radius*, that is 20 000000; there remains 10, 044935 which is the Secant of it, and ſo the Secant of 64 D. 23 M. is 9. 955065; which is the Complement of the former, becauſe they both are Equal to 20. 000000, the double *Radius*; and ſo may any other be found out.

CHAP.

CHAP. IV.

Of GEOMETRY.

Defin. THE End and Scope of Geometry is to measure well: for as Number or Multitude, is the Subject of Arithmetick: so is Magnitude that of Geometry: to measure well is therefore to consider the Nature of every thing that is to be measured; to compare such like things one with another: and to understand their Reason and proportion, and also their similitude: And this is the End and Scope of Geometry *.

* *Quod quæritur cognoscendi illius gratia, quod semper est, non & ejus quod oritur, quandoque & interit. Geometria, ejus quod est semper, Cognitio est. Ac tollet igitur (ô Generose vir) ad veritatem, animum : atque ita, ad Philosophandum preparavit cogitationem, ut ad supera convertamus : quæ nunc, contra quàm decet, ad inferiora dejicimus, &c.* Plato *lib. 7. de Rep.*

I shall not trouble you with the Definitions of Geometry, they being largely handled by many, and herein every one meanly conversant in the study of the Mathematicks is acquainted,

quainted, but shall immediately fall in hand with the principal Propositions, which chiefly concern the other following parts of this treatise.

SECT. I. §. 1.

The Explication of some Geometrical Propositions.

PROP. I.

To erect a perpendicular on any part of a line assigned.

LET the Line be A, B, and on the point D, 'tis required to raise a *perpendicular* to A, B, To operate which first open your Compasses to any convenient distance, and placing one foot thereof in D, with the other make the two marks C, and E, equidistant from D; then open the Compasses to some other convenient distance, and set one foot in E, and describe the *Arch* F F; then likewise in C, describe the *Arch* G G; then through the Intersections of these two *Arches*, and to the point D, draw H D, *perpendicular* to A B; as was required. Fig. 1.

PROP. II.

To Erect a Perpendicular, on the End of a Line.

Let the given line be A B, and on the End thereof at B, 'tis required to raise a *Perpendicular* Fig. 2.

dicular

§. 1. dicular line: To perform which open your Compasses to the distance B D, then on B as a Center, describe the Arch D, E, F, then from D, to E, place B D; then placing one foot in
Fig. 2. E, describe the Arch C F, then remove your Compasses to F, and draw the Arch C E; Lastly through their Intersection draw C B, which is a *Perpendicular* to AB, on the end B; as required.

PROP. III.

From a Point above to let fall a Perpendicular on a Line.

Fig. 3. Let the line given be B A, and 'tis required from the point above at C; to let fall a *Perpendicular* to the said Line: To perform which place one foot of your Compasses in C, and open them beyond the given line A B, and describe the Arch EF; divide EF, into two parts in D; Lastly draw CD, which shall be perpendicular unto AB, falling from the point above at C, as was so required.

PROP. IV.

To draw a right line Parallel to a right line, at any distance assigned.

Fig. 4. Let the distance assigned be O E, and the Line given be A B, and 'tis required to draw C D, *Parallel* to A B; at the distance O E: To perform which, take in your Compasses the distance O E, and on A, describe the

the *Arch* H, and on B, the *Arch* K; then draw C D, so as it may justly touch the two *Arches*, but cut them not, so shall C D; be parallel to A B, at the assigned distance O E, as was required. §. 1.

PROP. V.

To Protract an Angle of any Quantity of Degrees propounded.

Let it be required to *Protract*, or lay down an *Angle*, of 40 degrees: To perform which first draw a right line as A B, then open your Compasses to 60 degrees, in your line of *Chords*: and with that Distance on A, describe the *Arch* E F, then take 40 degrees in your Compasses out of your line of *Chords*, and place it on the *Arch*, from F, to H; Lastly through the point H, and from A draw A C; so shall the *Angle* CAB contain 40 degrees as required. *Fig.* 5.

PROP. VI.

To measure an Angle already protracted.

Let the *Angle* given be C A B, and 'tis required to find the Quantity thereof: To perform which take in your Compasses 60 degrees from your line of *Chords*, and on A, describe the Arch E F; then take in your Compasses the Distance F H, and apply it to your line of *Chords*; and you will find the *Angle*, C A B to contain 40 degrees. *Fig.* 5.

§. 1.

PROP. VII.

To divide an Angle into two Equal parts.

Let the *Angle* given be B A C, and 'tis required to divide it into two equal parts: To perform which do thus: first take in your Compasses any convenient distance, and placing one foot in A, describe the *Arch* F K H E,
Fig. 6. then on H, describe the *Arch* K K, and on K, the *Arch* H H; lastly through the *Intersections* of these *two Arches*, draw the line A D, to the *Angular point* A; so shall the *Angle* BAC, be divided into two equal parts, *viz.* BAD, and DAC; as required.

PROP. VIII.

To divide a right line into any Number of Equal or Unequal parts; or like to any divided line propounded.

Let the line A B, be given to be divided into 5 equal parts; as the line CD. To perform which do thus: first on the point C, draw out a line making an *Angle* with CD at pleasure: then make CF, equal to AB; and joyn their Extremities FD, then draw *Parallel lines*
Fig. 7. to FD, through all the 5 points of CD, (by the 4 prop. aforegoing) which shall divide AB, into 5 equal parts; as required: This way is to be observed, when the line given to be divided, is greater than the divided line propounded.

CASE II.

CASE II.

§. 1.

But if AB, be ſhorter than the given divided line CD; take the line AB, in your Compaſſes, and on D ſtrike the *Arch* F, then draw the *Tangent* CF, then take the neareſt diſtance from the firſt diviſion of CD, to the *Tangent-line* CF, which diſtance ſhall divide AB into 5 equal parts, as the given divided line CD; as required. *Fig.* 8.

Thoſe two propoſitions well underſtood, doth demonſtrate many other propoſitions, and thereon is grounded the Uſe of the Sector.

PROP. IX.

How to Protract or lay down any of the Regular Figures, called Polygons.

To perform which divide 360 degrees, (the number of degrees in a Circle) by the number of the *Poligon* his ſides: as if it be a *Pentagon* by 5, if a *Hexagon* by 6, *&c.* the Quotient is the Angle of the *Center*; its *Complement* to 180D. (or a Semi-circle) is the Angle at the *Figure*, half whereof is the Angle of the *Triangle* at the *Figure*: Now I will ſhew how to delineate any *Poligon* three ways, *viz.* 1. by *the Angle at the Center*, 2. *by the Angle at the Figure*, 3. *by the Angle of the Triangle at the Figure*: I have hereunto annexed a Table, which gives at the firſt ſight, (without the trouble of Diviſion) 1. the quantity of the Angle at the Center; 2. the quantity of the Angle at the

Figure,

§. 1. Figure; and 3 the Quantity of the Angle at the Triangle of the Figure, from a Triangle to a Decigon.

Names of the *Poligons.*	Sides	Angles at the Center		Angles at the Figure		Angles at the Trian.	
		D	M	D	M	D	M
Triangle	3	120	00	60	00	30	00
Square	4	90	00	90	00	45	00
Pentagon	5	72	00	108	00	54	00
Hexagon	6	60	00	120	00	60	00
Heptagon	7	51	43½	128	34½	64	17¼
Octogon	8	45	00	135	00	67	30
Nonigon	9	40	00	140	00	70	00
Decigon	10	36	00	144	00	72	00

CONSTRUCTION I.

First by *the Angle at the Center*, to delineate a *Hexagon*, whose Angle at the Center is 60 degrees, first lay down an Angle of 60 deg. (by prop. the 5. aforegoing) making its sides of a convenient length at pleasure, then take such a distance from O the Center of the figure, equally on both sides, as may make the third side equal to the side of the *Poligon* given; which here is 100 parts: * Then divide the third side equally into two equal parts, and draw a line through it, from ⊙ the Center: set

Fig. 9.

** But this in a Hexagon need not be done, because the 3 sides of the Triangle are equal, but in all other Poligons it must be done.*

set each half of the side of the *Poligon* 100, to wit 50, on each from the middle of the third line: † thus having placed the side of the *Hexagon* PP, 100 parts, in order; describe the whole *Hexagon* PPPPPP, as was required. §. 1.

† *But if the third line do exceed or be short of the side of the Poligon propounded, then by parallels on each side, cut the sides of the Triangle, till you have found by those Intersections where to set the line proposed, in any Poligon*, &c.

CONSTRUCTION II.

Now by the *Angle of the Figure*, to delineate any regular *Poligon*, Let it be required to protract a *Hexagon*, whose side as afore is 100 parts; first I draw a line and make it 100 of those parts, then I find in the precedent Table the Angle of a *Hexagon* at the figure to be 120 degrees: Then on each side of the drawn line, I lay down an Angle of 120 deg. (according to the 5 precedent propositions) and so work 6 times, (or as many times as your *Poligon* hath sides) making each side 100 parts, *Fig.* 10. and each Angle 120 degrees; so shall you have enclosed the *Poligon* PPPPPP, as required.

CONSTRUCTION. III.

To Protract or lay down a *Hexagon*, or any other regular *Poligon*, *by the Angle of the Triangle*, do thus; First draw the side of the *Fig.* 11 *Hexagon* P P, make it 100 parts. I find in the precedent Table that the Angle of the Triangle is 60 deg; then at each end of the line P P, I

§. 1. ☞ *Observe these Rules well, for you will find them of infinite use in Fortification, &c.*

lay down an Angle of 60 deg. (by prop. 5. precedent) and continue the two lines PO, and PO; untill they intersect each

Fig. 11. other in O: then on O, as a Center (OP: being *Radius*) describe a Circle, and within it describe the *Hexagon* PPPPPP, as you see in the figure: and so may you delineate any other *Poligon*: whose Angels from a *Triangle*, to a *Decigon*, are all specified in the precedent Table.

PROP. X.

To divide a line according to any assigned proportion.

Admit the right line given to be AB, and 'tis required to divide the same into two parts, bearing proportion the one to the other as the lines E, and F doth: To perform which, first draw the line CD, equal to the given line AB: Then draw the line HC, from C, to contain

Fig. 12. an Angle at pleasure. Then from C to G, place the line F, and from G, to H, place the line E: Then draw the line HD. And lastly, draw GK parallel to HD, (by the 4 prop. precedent) so is the line DC, equal to AB, and divided into two parts, bearing such proportion to each other, as the two given lines E, and F, as was required.

PROP.

§. 1.

PROP. XI.

To two lines given, to find a third proportional to each of them.

Admit the two given lines be A and B, and 'tis required to find a third proportional to A, as A, to B: First make an Angle at pleasure; as HIK. Then place the line B, from I, unto P; and the line A, from I, unto L; and draw PL. then also place the line A, from I unto M, and draw QM, parallel unto LP, (by 4 prop.) so shall the line IQ, be a third proportional unto the two given lines A, and B, as was required. For as B, is to A, so is A, unto the proportional found IQ. *Fig.* 13.

PROP. XII.

To three lines given to find out a fourth proportional unto them.

Admit the three given lines to be A, B, and C; and 'tis required to find a third proportional to them, which shall have such proportion unto A, as B, hath unto C. To perform which, first make an Angle at pleasure as DKG, now seeing the line C, hath such proportion to B, as the line A, unto the line sought: Therefore place the line C, from K, unto H and B, from K, to F, and draw FH. Again, place the line A, from K, to I, and draw IE, parallel unto FH, (by 4 prop.) until it cutteth DK, in E; so have you the line KE, a fourth proportional, as was required. For as C, is unto B, so is A, unto the found line KE. *Fig.* 14.

PROP.

§. 1. ## PROP. XIII.

To find a mean proportional Line between any two right lines given.

Let the two given lines be A, and B, between which it is required to find a mean proportional line. To perform which, first joyn the two lines A, and B together, so as they make Fig. 15. the right line CED: Then describe thereon a *Semicircle* CFD. Then on the point E, erect the *perpendicular* EF, (by 1 prop.) to cut the limb of the *Semi-circle* in F, so shall EF, be a mean proportional line, between the two given lines A, and B, as required.

PROP. XIV.

To find two mean proportional Lines between any two right Lines given.

Fig. 16. Let the two given lines be A, and B; between which 'tis required to find two mean proportionals. To perform which, first make an Angle containing 90 deg. making the sides CD, and CE of a convenient length: then from C, place the line B, unto F, and the line A, from C, unto G; and draw FG, which divide equally in H, and describe the *Semi-circle* FKG. Then take the line B in your Compasses, and placeing one foot in G, with the other make a mark in

And this of all other the Inventions of Plato, Apollonius, Sporus, Architas, Diocles, Nicomedus; *& many other famous Geometricians and Philosophers, I like best for the ready performance of this Conclusion, whose several Methods I could here describe, but for brevity sake do omit them.*

in the limb of the *Semi-circle* in K, then draw ST, in such sort that it may justly touch the Semi-circle in K, and may cut through the two sides of the Angle, equidistant from the Center of the *Semi-circle* H; so shall SF, and TG, be two *mean proportionals*, betwixt the two given lines A, and B, as required. §. 1.

PROP. XV.

To make a Geometrical square equal to divers Geometrical squares.

Let there be given the 5 sides of five *Geometrical Squares, viz.* A, B, C, D, E; and 'tis required to make one *Geometrical Square*, equal to the said five Sqares: To perform which first make a Right Angle as ABC, making its contained sides of a convenient length. Then from B, place A, to D, and from B, place B, to E, and draw ED. Then place ED, from B, to F, and C, from B, to G; and draw GF. Then place GF, from B, to H, and D, from B, to I; and draw IH. Lastly from B, unto K, place IH, and from B, unto L, place the line E; and draw LK. So shall LK, be the side of a Square, equal to the five Squares propounded. *Fig.* 17.

PROP. XVI.

To make a Circle equal to divers Circles propounded.

Let the two Circles propounded be A, and B, and 'tis required to make a third Circle, equal to the said Circles propounded. To perform *Fig.* 18.

§. 2. form which, first take the Diameter, of the lesser Circle A, and place it as a *Tangent*, on the *Diameter* of the greater Circle B, at *right Angles*; as ECD. Then draw the *Diagonal* ED, which divide equally in F, on which as a Center describe the Circle K, making E D, the *Diameter* of which Circle K shall be equal unto the two given Circles A, and B, as required *.

Fig. 18.

* *So after the same manner, may divers Circles be added into one by the help of the former proposition well understood.*

SECT. II.

Of Planometry, *or the way to measure any plain Superfice.*

PLanometry is that part of the *Mathematicks*, derived from that Noble Science *Geometry*, by which the *Superficies* or *Planes* of things are measured, and by which their *Superficial Content* is found, which is done most commonly by the Squares of such Measures, *Viz. a Square Inch*, *Square Foot*, *Square Yard*, *Square Pace*, *Square Perch*, *&c.* That is whose side is an *Inch*, *Foot*, *Yard*, *Pace*, or *Pearch Square*. So that the Content of any Figure is said to be found, when you know how many such *Inches*, *Feet*, *Yards*, *Paces*, *&c.* are contained therein: Thus the End and Scope of *Geometry* is to measure well.

PROP.

§. 2.

PROP. I.

To find the superficial Content of a Geometrical square.

Let the side of the Square AA be 4 *Perch*, what is the *Area*, or superficial content thereof? To find which multiply its side 4, by its self, it produceth 16, which is the content of that Square AAAA, propounded. *Fig.* 19.

PROP. II.

To find the superficial content of a Parallelogram, or long Square.

Multiply the length in parts, by the breadth in parts; the product is the content thereof. So in the *Parallelogram*, or long Square ABCD, the length of the side AB, or CD is 20 *Paces*, and the breadth AC, or BD is 10 paces, and his superficial content is required. I say therefore if according unto the Rule, you multiply the length 20, by the breadth 10, it produceth 200 Paces; which is the content of the *Parallelogram* or long Square ABCD. *Fig.* 20.

PROP. III.

To find the Superficial Content of any Right-lined Triangle.

Although right-lined Triangles are of several kinds, and forms; as first in respect unto their Angles, they are either *Right-angled*, or

Oblique-

§. 2. *Oblique-angled*, *i. e. Acute-angled*, or *Obtuse-angled*. Secondly in respect of their sides, they are either an *Equilateral*, *Isosceles*, or *Scalenium Triangle*: But now seeing they are all measur'd by one and the same manner, I shall therefore add but one Example for all; which take for a general Rule: which is,

The Rule. Multiply the length of the *Base*, by the length of the *Perpendicular*; half their product is the *Area* or superficial content thereof. So if the content of the *Triangle* ABC, be required. To find which first from the Angle B, let fall the *Perpendicular* DB, on the *Base* AC, (by

Fig. 21. prop. 3. §. 1.) let therefore the length of the *Perpendicular* BD be 24, and the *Base* AC 44 parts. Now if the *Base* AC 44, were multiplyed by BD 24, the product is 1056, half whereof is 528, the Content of the *Triangle* ABC, propounded.

PROP IV.

To find the superficial Content of a Rhombus.

First let fall a *Perpendicular* from one of the *Obtuse-angles*, unto its opposite side, (by prop. 3. §. 1.) and then Multiply the length of the side thereof, by the length of the *Perpendicular*, their product is the Content thereof.

So in the *Rhombus* ABCD, the side AC, or

Fig. 22. BD is 16 *Inches*, and the *Perpendicular* KC is 14 *Inches*, which multiplyed into the side 16, produceth 224 *Inches*; which is the *Area*, or superficial Content, of the *Rhombus* ABCD, propounded.

PROP.

PROP. V. §. 2.

To find the superficial content of a Rhomboides.

Frst let fall a *Perpendicular*, as in the former proposition, then the length thereof multiply by the length of the *Perpendicular*; the product is the *Area*, or superficial content thereof. For in the *Rhomboides* EDAH, whose length AH, or ED is 32 *Feet*, and the length of the *Perpendicular* HK is 16 *Feet*, which multiplyed together produceth 512 *Feet*, which is the *Area* or superficial content of the *Rhomboides* AHED, propounded. *Fig.* 23.

PROP. VI.

Te find the superficial Content of any Poligon, or many equal sided Superficies.

First from the *Center* unto the middle of either of the sides of the *Poligon*, let fall a *Perpendicular*, (by 3. prop §. 1.) Then multiply the length of half the *Perifery*, by the *Perpendicular*, the product shall be the *Superficial Content* of the *Poligon*.

Admit the *Poligon* to be an *Hexagon* AAAA AA, whose side AA is 22 *Feet*, and the *Perpendlcular* BE 19 *Feet*; now, if 66 half the *Perifery*, be multiplyed by 19 it produceth 1254 *Feet*; which is the *Content* of the *Poligon* AA, &c. as required. *Fig.* 24.

PROP.

§. 2.

PROP. VII.

To find the superficial Content of a Circle.

Multiply half the *Circumference*, by one half of the *Diameter*, their product is the *superficial Content* thereof.

Admit the *Circumference* of a *Circle* ACBD, be 44 *Inches*, what is the *Area* or *Content* thereof. (by the 9 prop. §. 2.) I find the *Diameter* to be 14 *Inches*, therefore I say if 22, half the *Circumference*, be multiplied by 7, half the *Diameter*, it shall produce 154 *Inches*; which is the *superficial Content* of the *Circle* ACDB, as required.

Fig. 25.

PROP. VIII.

By the Diameter of a Circle given, to find the Circumference.

Suppose the *Diameter* be 14, what is the *Circumference*? The *Analogy* or *Proportion* holds thus, as 7, to 22, so is 14, unto 44, the *Circumference* required.

PROP. IX.

By the Circumference of a Circle given, to find the Diameter.

Suppose the *Circumference* of a *Circle* be 44, what is the *Diameter*? the *Analogy* or *Proportion* is, as 22, to 7, so is 44, unto 14, the *Diameter* required.

Now

Now the proportion of the *Diameter*, unto the *Circumference* is as 7, unto 22; or as 113, to 355; or as 1, unto 3, 1415926, *&c.* so is the *Diameter* to the *Circumference.* §. 2.

PROP. X.

By the Content of a Circle given, to find the Circumference.

Suppose the Content of a *Circle* be 154; what is the *Circumference*, the *Analogy* or *Proportion?*

As 7, unto 4 times 22, which is 88, so is 154 the Content of the given *Circle*; to the square of the *Circumference* 1936, whose root being Extracted, as is taught (in prop. 8. §. 1. chap. 1.) gives the *Circumference* 44, as required.

PROP. XI.

By the Content of a Circle given, to find the Diameter.

Suppose the *Superficial Content* of a *Circle* be 154 parts, what is the *Diameter* thereof? to find which this is the *Analogy* or *Proportion.*

As 22,
To 4 *times* 7, *which is* 28,
So is 154, *the given Content*,
To the *Square of the Diameter* 196, whose *Root* being Extracted (by 8 prop. chap. 1. §. 1.) giveth the *Diameter* 14, as required.

§. 2.

PROP. XII.

By the Diameter of a Circle given to find the side of a square equal thereto.

To find which this is the *Analogy* or *Proportion.*

As 1, 000000,
To 0, 886227.
So is the *Diameter of the Circle propounded.*
To the side of a Square, whose *superficial Content*, is equal unto the *superficial Content*, of the *Circle* propounded.

PROP. XIII.

By the Circumference of a Circle given, to find the side of a square equal to it.

This is the *Analogy* or *Proportion.*
As 1. 000000,
To 0. 282093.
So is the Circumference of the Circle propounded, *to the side of a Square equal to the Circle.*

PROP. XIV.

By the Content of a Circle given to find the side of a square equal to it.

To do which, Extract the *Square-Root* of the Content propounded, (by prop. 8 chap. 1. §. 1.) so is the *Root*, the side of a *Geometrical Square*, equal thereunto.

PROP.

§. 2.

PROP. XV.

By the Diameter of a Circle given, to find the side of an Inscribed square.

This is the *Analogy* or *Proportion.*
As 1. 000000,
To 0. 707107;
So is the Diameter of the Circle propounded; *To the side of the inscribed Square.*

PROP. XVI.

By the Circumference of a Circle given, to find the side of an Inscribed Square.

This is the *Analogy*, or *Proportion.*
As 1. 000000,
To 0. 225079.
So is the Circumference of the Circle propounded, *To the side of the inscribed Square.*

PROP. XVII.

To find the Superficial Content of an Oval; or Elleipsis.

Let the *Oval* given be ABCD, and 'tis required to find the *Area* or *Superficial Content* thereof? To do which multiply the length AB 40 *Inches*, by the breadth CD 30 *Inches*, the *Product* is 1200. Which divide by 1. 27324; the *Quotient* is 942$\frac{48}{100}$ parts. Which is the *Area of Superficial Content* of the *Oval* ABCD propounded *Fig.* 26.

PROP. XVIII.

To find the Superficial Content of any Section, or Portion of a Circle.

Multiply half the *Circute* of the *Section*, by the *Semidiameter* of the whole *Circle*, and the product thence arising is the *Area* or *superficial Content thereof.*

Fig. 27. Suppose there be a *Circle* whose *Diameter* is 14 parts, and the *Circute* of the *Quadrent* ABC is 11 parts, and the Content of the said *Quadrent* is desired? To find which multiply $5\frac{1}{2}$ or, 5.,5 half the *Circute* of the *Quadrent*, by 7 the *Semidiameter*, the product is $38\frac{5}{10}$, which is the Content of the *Quadrent* ABC propounded.

---

§. 3.

SECT. III.

Of STEREOMETRY, *or the way how to measure any Regular Solid.*

STereometry is that part of the *Mathematicks*, springing from *Geometry*, by which the Content of all *solid Bodies* are discovered by two *Multiplications*, or three *Dimentions* and is valued by the *Cube* of some famous Measure; as an *Inch-Cube, a Foot-Cube, a Yard Cube, or a Perch-Cube*, &c.

PROP

§. 3.

PROP. I.

To find the ſolid Content of a Cube.

Multiply the ſide into its ſelf, and that product by its ſide again; their product is the ſolid Content thereof.

Suppoſe there be a *Cube* A, whoſe ſide is 2 Feet; and his ſolid Content is required? I ſay if his ſide 2, be multiplyed by its ſelf, it produceth 4, which again multiplyed by 2, it produceth 8 Feet, which is the ſolid Content of the *Cube* propounded. *Fig.* 28.

PROP. II.

To find the ſolid Content of a Parallelepipedon.

Firſt get the *Superficial Content* of the End, (by prop. 1, or 2, §. 2.) which multiply into the length, the product is the *ſolid Content.*

Suppoſe there be a *Parallelepipedon* B, whoſe ſides of the *Baſe* is 40, and 30 *Inches*, and length 120 *Inches*, and his *Solid Content* is demanded? I ſay if you multiply 30, by 40, the product is 1,200, which is the *ſuperficial Content* at the *Baſe*. Which multiplyed by the length 120 Inches produceth 144000 Inches, which is the *ſolid Content* of the *Parallelepipedon* B, propounded. *Fig.* 29.

§. 3.

PROP. III.

To find the solid Content of a Cylinder.

First get the *superficial Content* of the Circle at the *Base*, (by prop. 7. §. 2.) and by it multiply its length, their product is the *solid Content* thereof.

Fig. 30. Suppose there be a *Cylinder* as D, whose *Diameter* of the *Circle* at the *Base* is 7 parts, and the length of the *Cylinder* is 14 parts, and 'tis required to find the *solid Content* thereof? First I find the *superficial Content* of the *Base* to be 38.5, which multiplied into 14 the length, giveth 539 parts, which is the *solid Content* of the *Cylinder* propounded.

PROP. IV.

To find the solid Content of a Pyramid.

First get the *superficial Content* of the *Base* of the *Pyramid*, (by some of the aforegoing propositions in *Planometria*) and then multiply that into $\frac{1}{3}$ of his *Altitude*, the product is the *solid Content* thereof.

Suppose there be a *Pyramid* H, whose side of the *Base* is $4\frac{1}{2}$ parts, or $4\frac{5}{10}$, and his *Altitude* 12 parts, and his *solid Content* is required? First

Fig. 31. I find, (by prop. 1. §. 2.) the *superficial Content* of the *Base* to be $20\frac{25}{100}$ or $20\frac{1}{4}$, which multiplyed by 4, (which is $\frac{1}{3}$ of the *Altitude* 12) produceth 81 parts, for the *solid Content* of the *Pyramid* propounded.

PROP.

§. 3.

PROP. V.

To find the ſolid content of a Cone.

Firſt find the *ſuperficial Content* of the *Circle* at the *Baſe*, (by prop. 7. §. 2.) then multiply it by $\frac{1}{3}$ of its *Altitude* or Heighth, the product is the *ſolid Content* thereof.

Suppoſe there be a *Cone* as B, whoſe *Diameter* of the *Baſe* is 7, and his *Altitude* or Heighth is 15 parts, and his *ſolid Content* is required? Firſt I find the *ſuperficial Content* of the *Baſe* to be $38\frac{1}{2}$ or 38. 5; which multiplyed into 5, ($\frac{1}{3}$ of its *Altitude* or Heighth) produceth 192. 5, or $\frac{1}{2}$, which is the *ſolid Content* of the *Cone* propounded. Fig. 32.

PROP. VI.

By the Diameter of a Globe to find his ſolid Content.

This is the *Analogy* or *Proportion*.
As 6 times 7, *which is* 42.
Is to 22,
So is the Cube of the Diameter of the Sphere, or Globe propounded.
To the ſolid Content thereof.

Suppoſe there be a *Sphere* or *Globe*, whoſe *Diameter* is 12 Inches; what is the *ſolid Content* thereof? ſay, (ſee the *Globe* R.)

As 42, Fig. 33.
Is to 22,
So is 1728, *the Cube of the Diameter*,

6. 3. *To the solid Content* $905\frac{6}{42}$ or $\frac{1}{7}$ *of the Globe, or Sphere* propounded: This and all other such like Propositions, are performed by the help of the first Proposition, of the first Chapter of this Book.

☞ *Note that every Sphere is equal unto two Cones, whose Height and Diameter of the Base is the same with the Axis of the Sphere. And a Sphere is two thirds of a Cylinder, whose Height and Diameter of the Base is the same with the Axis of the Sphere: according unto the 9th. Manifestation of the first Book of* Archimedes *of the Sphere and Cylinder*

PROP. VII.

By the Circumference of a Sphere, or Globe, to find his solid Content.

This is the *Analogy* or *Proportion.*
As 1. 000000,
To 0 016887,
So is the Cube of the Circumference of the Globe or Sphere propounded
To the solid Content thereof.

PROP. VIII.

By the Axis of a Globe, to make a Cube equal thereunto.

This is the *Analogy* or *Proportion.*
As 1. 00000,
To 0. 80604,
So is the Axis of the Sphere propounded,
To the *Cube-Root*, which shall be equal to it.

PROP.

§. 3.

PROP. IX.

By the Circumference of a Globe, to make a Cube equal thereunto.

This is the *Analogy* or *Proportion.*
As 1. 000000,
To 0. 256556.
So is the Circumference of the Globe propounded,
To the *Cube-Root*, which ſhall be equal to the *Sphere*, or *Globe*, propounded.

PROP. X.

By the ſolid Content of a Sphere or Globe, to make a Cube equal thereunto.

Extract the *Cube-root* of the *ſolid Content* of the *Sphere* or *Globe*, (by prop. 9. §. 1. chap 1.) ſo ſhall the Root, ſo found, be the ſide of a *Cube*, equal unto the *Globe* or *Sphere* propounded.

PROP. XI.

A Segment of a Sphere being given to find the ſolid Content thereof.

To find which firſt ſay, *As* the *Altitude* of the other *Segment*, is to the *Altitude* of the *Segment*

§. 3. *ment* given: so is that *Altitude* of the other *Segment* increased by half the *Axis*, unto a *fourth*: Then say, *As* 1, *to* 1, 0472, *so is the product of the Quadrant of half the Chord of the Circumference of that Segment, multiplyed by that fourth, To the solid Content of the Segment propounded.*

CHAP.

---

§. 1.

CHAP. V.

Of TRIGONOMETRY.

Or the Doctrine of Triangles.

SECT. I.

Some general Maxims, belonging to plain or Right-lined Triangles.

TRIGONOMETRY is necessary in most parts of the *Mathematicks*, and herein indeed consisteth the most frequent use of the *Logarithms*, *Sines*, *Tangents*, and *Secants*: It is conversant in the measuring of *Triangles*, *Plain* or *Spherical*, comparing their *Sides*, and *Angles* together; according unto their known *Analogies*, or *Proportions*: So that any three parts of a *Triangle* being given, the other parts may be found out, and known: Now in the *Doctrine* of *Right-lined Triangles*, it will be necessary to know these *Maxims* following.

1. That

§. 3. 1. That a *Right-lined Triangle*, is a Figure constituted, by the Conjunction, or Intersection, of the three Right, or Streight-lines thereof; in their Angles or Meeting-places. So that every *Triangle* hath six distinct parts, *Viz. Three Sides*, and *three Angles*.

Fig. 34. 2. That all *Right-lined Triangles*, are either *Right-angled*, That is, which hath one *Right-Angle*, as ABC Fig. 34. *Or Oblique-angled*, whose three *Angles* are all *Acute*; that is, less than a *Quadrant*, or 90 deg; or else they have *One Angle Obtuse*, or greater than a *Quadrent*:

Fig. 36. So all *Triangles*, that have not one *Right-angle*, are called *Oblique-Triangles*; as Fig. 36. to wit, the *Triangle* ABC.

3. That the three *Angles*, of any *Right-lined Triangle*, are equal unto two *Right-angles*; or 180 *Degrees*. So that any two of their *Angles* being known, the third *Angle* is also found, being the *Complement* of the other two; unto 180 *Degrees*: But this is more readily found in a *Rectangled Triangle*, for the *Rectangle* being a *Quadrent*, or 90 degrees, one of the acute *Angles* therefore being given, the other is readily known, being the *Complement* thereof unto 90 *Degrees*.

Fig. 35. 4 That the three sides, comprehending the *Triangle*, some call *Leggs*, others *Sides*, but in *Rectangled Triangles*, as in the *Triangle* ABC, I call AB, *the Base*, BC the *Cathetus* or *Perpendicular*; and AC the *Hypothenuse*.

5. That the *Sines*, of the *Angles* are proportional unto their opposite *Sides*; and their *Sides*, to their opposite *Angles*. So that if the *Side* of a *Triangle* were desired, put the *Sine* of the opposite

ſite *Angle* in the firſt place. Alſo if an Angle be required, put the *Logarithm* of his oppoſite ſide in the *firſt place*. §. 3.

6. That the ſides of any *Rectangled Triangle* may be meaſured by any *Scale* of equal parts, as *Inches*, *Feet*, *Yards*, *Poles*, *Miles*, *Leagues*, &c.

7. That if an *Angle* propounded, be greater than 90 *deg.* and ſo not to be found in the *Tables*, take the *Complement* thereof, unto 180 *deg.* and work by the *Sine*, or *Tangent* thereof, and the work will be the ſame.

And here for the more ſhort, and ſpeedy performance of theſe concluſions in *Trigonometry*; I have annexed, and uſed, theſe following *Symbols*; which I would have you take notice of.

= *Equal, or Equal to.*	X *Difference.*
✠ *More.*	S *Sine.*
− *Leſs.*	Sc *Co-ſine.*
x *Multiplyed by.*	T *Tangent.*
° *Degrees as* 15°.	Tc *Co-tangent.*
′ *Minutes as.* 40′.	Se *Secant.*
cr. *A Side.*	Sec *Co-ſecant.*
crˢ, *Sides.*	Co.Ar. *Compl. Arithmetic.*
V An Angle.	R *A Right-angle.*
VV Angles.	2 R *Two Right-angles.*
Z *Sum.*	Q *Square.*

SECT.

§. 2.

SECT. II.

Of Plain Rectangled Triangles.

PROP. I.

Two Angles and the Base of a Rectangled Triangle given, to find the other parts.

Fig. 34. ADmit the *Triangle* given be ABC : Now the *Angle* at B, is an *Angle* of 90°, or a *Right-angle* ; And the *Angle* at C is 57° 35′, and the *Base* AB ; is 736 parts.

Now first I find the *Angle* at A, to be 32° 25′ : it being the *Complement* of the *Angle* at C, unto 90° : Secondly, to find the *Cathetus*, or *Perpendicular*, this is the *analogy* or *proportion*.

As S, *V*, C, 57° 35′ —— 9.92643

To Log. AB. *Base* 736 *parts* —— 2. 86687
So is S. *V*. A. 32° 25′ —— 9. 72922

12. 59609

To Log. of the Cathetus, or Perpendicular BC $467\frac{4}{10}$ *parts.* } —— 2. 66966

Add the *Log.* of the third and second *Terms* together, and from their Sum, deduct the *Log.* of the first number, so is the Remainder, the *Log.* of the

Observe this for a general Rule in Trigonometry.

the fourth *Term*, or Number sought, as you see in the aforegoing *Example*. §. 2.

Thirdly to find the *Hypothenuse* AC, the *Analogy* or *Proportion* hold thus.

As S. *V*, C 57° 35′,

To Log. Base AB 736 *parts.* Fig. 34.

So Radius or S. 90°,

To Log. Hypothenuse AC $871\frac{8}{10}$ *parts required*: Thus are the three required parts, of the given *Triangle* ABC found, *viz.* the *Angle* A to be 32° 25′, the *Cathetus* BC to be $467\frac{4}{10}$ parts, and the *Hypothenuse* AC to be $871\frac{8}{10}$ parts, as was so required to be found.

PROP. II.

The Hypothenuse, *Base, and one of the Angles Of a Rectangled Triangle given, to find the other parts thereof.*

In the *Triangle* ABC, the *Hypothenuse* AC is $871\frac{8}{10}$ parts, the *Base* AB is 736 parts, and the *Angle* at B, is known to be a *Right-angle*; or 90°: *First* to find the *Angle* at the *Cathetus* C, the *analogy* or *proportion* holds thus.

As Log. Hypothen: AC $871\frac{8}{10}$ *parts* Fig. 34.

To Radius or S. 90°.

So Log. Base AB 736 *parts*,

To the S. *V. at Cathetus* C 57° 35′.

Secondly, now having found the Angle at the *Cathetus* C, to be 57° 35′; I say the Angle of the *Base* A is 32° 25′, being the *Compl.* of the Angle C, unto 90°.

Thirdly to find the *Cathetus* BC, this is the *analogy*; or *proportion*.

As

§. 2. *As Radius* or S. 90°,
To Log. Hypothen. AC 871 $\frac{8}{10}$ *parts*,
Fig. 34. So S. *V. at Base* A 32° 25′.
To Log. Cathetus BC, 467 $\frac{4}{10}$ *parts required*;
It may also be found, as in the former Proposition.

PROP. III.

In a Rectangled Triangle, the Base, and Cathetus *given to find the other parts thereof.*

In the Triangle ABC, *the Base* AB is 736 parts, and the *Cathetus* BC is 467 $\frac{4}{10}$ parts, and the Angle B, between them is *a right angle*; or 90°: And here you may make either side of the Triangle, *Radius*, but I shall make BC, the *Cathetus Radius*, and then to find the Angle at the *Cathetus* C, this is the *Analogy* or *Proportion*.

Fig. 35. *As Log. Cathet.* BC 467 $\frac{4}{10}$ *parts*,
To Radius or S. 90°.
So Log. Base AB 736 *parts*,
To T. *V. Cathe.* C 57° 35′, as *required*.

Secondly, I find the other Angle, at A to be 32° 25′, it being the *Complement*, to C 57° 35′, unto 90°.

Thirdly, To find out the *Hypothenuse* AC, this is the *analogy* or *proportion*.

As S. *V.* Cathe. C. 57° 35′,
To Log. Base AB 736 *parts*,
So Radius or S. 90°,
To Log. Hypothenuse AC 871 $\frac{8}{10}$ *parts*, *required*. But making the *Base* AB *Radius*, you may find the *Hypothenuse* AC, by this *analogy* or *proportion*.

As

Plate 1

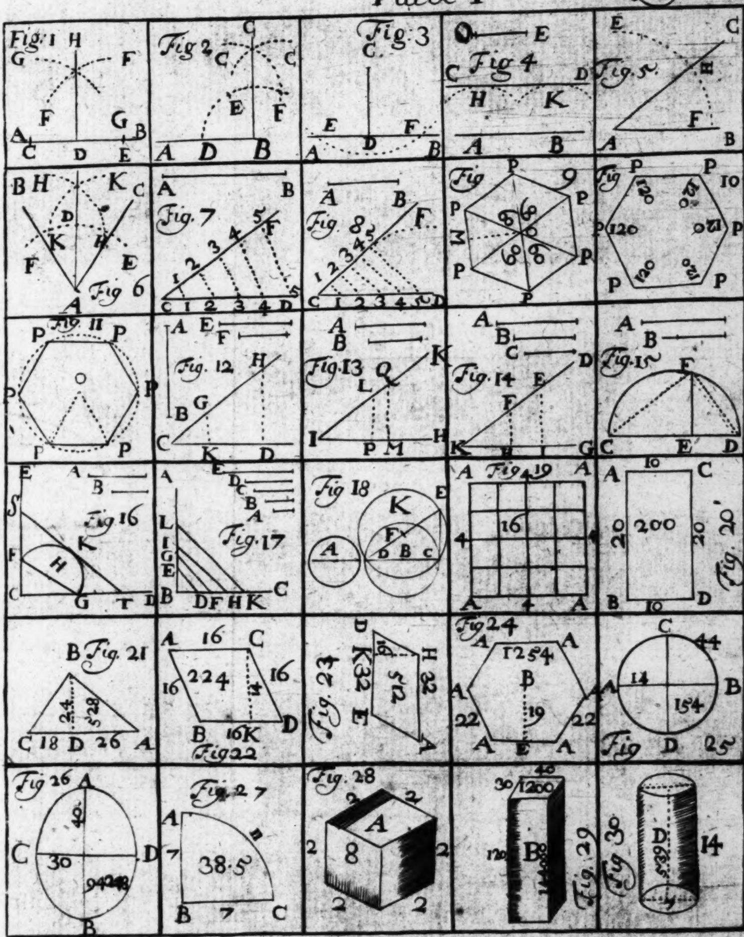
Fig. 1
Fig. 2
Fig. 3
Fig. 4
Fig. 5
Fig. 6
Fig. 7
Fig. 8
Fig. 9
Fig. 10
Fig. 11
Fig. 12
Fig. 13
Fig. 14
Fig. 15
Fig. 16
Fig. 17
Fig. 18
Fig. 19
Fig. 20
Fig. 21
Fig. 22
Fig. 23
Fig. 24
Fig. 25
Fig. 26
Fig. 27
Fig. 28
Fig. 29
Fig. 30

As Radius or S. 90°, §. 2.
To Log. Base AB 736 *parts.*
So Sc. *V. Base* A 32° 25′,
To Log. Hypothenuse AE 871 $\frac{8}{10}$ *parts required,* *Fig.* 35.
and thus you have all the parts of the Triangle propounded.

PROP. IV.

The Base, and Hypothenuse, with the Angle between them given, to find the other parts of a Rect-angled Triangle.

In the Triangle ABC, the *Base* AB is 736 parts, and the *Hypothenuse* AC is 871 $\frac{8}{10}$ parts, and the Angle A included between them is 32° 25′. *First* to find the Angles, and first remember that the Angle B is a right Angle; or 90°. *Secondly,* that the Angle at C, is the *Complement* to the Angle at A 32° 25′ unto 90°: *Fig.* 35. and therefore is 57° 35′: Now these being known, you may find the *Cathetus,* by this *analogy* or *proportion.*

As S. V. Cathe. C 57° 35′,
To Log. Base AB 736 *parts.*
So S. V. Base A 32° 25′,
To Log. Cathe. BC 467 $\frac{4}{10}$ *parts required.* Thus I have sufficiently explained all the *Cases* of *Plain Rect-angle Triangles,* for to these rules they may be all reduced.

§. 3.

SECT. III.

Of Oblique-Angled Plain Triangles.

PROP. I.

Two Angles, and a side opposite, in an Oblique-Angled Triangle given, to find the other parts thereof.

IN the Triangle ABC, the Angle at A is 50°, and at C is 37°, and the side AB is 30 parts, and opposite to the Angle C.

First, to find the Angle B, remember that (as 'tis said, in the third *Maxim* aforegoing) 'tis the *Complement*, to the Angles A 50°, and C 37°, to 180°, and therefore is the Angle at B 93°.

Fig. 36. *Secondly*, having thus found the Angles, the two unknown sides, may be found by the proportion they bear to their opposite Angles, for that proportion holds also in these; thus to find the side BC, this is the *analogy or proportion.*

As S. *V*. C 37° 00′,
To Log. side AB 30 *parts.*
So S. *V*. A. 50° 00′,
To Log. side BC 38 $\frac{19}{100}$ *parts required to be found.*

But it may be more readily found, and performed in such case as this, where you have a *Sine*, or *Tangent*, in the first place, by the *Arithmetical Complement* thereof, and so save the *Substraction.*

Now

§. 3.

☞ *The Rule to find the Complement Arithmetical, of any Logarithm Number.*

Now the readiest way to find the *Arithmetical Complement* is that of *Mr. Norwood*, in his *Doctrine of Triangles*; which is thus: begin with the first Figure towards the left hand of any *Number* and write down the *Complement*; or the remainder thereof, unto 9: And so do with all the rest of the *Figures*, as you see here done.

——— 9. 962398.
——— 0. 037602.

Saying 9, wants of 9, 0: and again 9, wants 0: 6, wants 3; 2, wants 7: 3, wants 6; 9, wants 0: only when you come to the last Figure to the right hand, take it out of 10, so 8, wants 2; of 10: Thus you may readily find the *Co-Ar.* of any *Sine*, almost as soon as the *Sine* it self.

But if you want the *Complement Arithmetical* of any *Tangent*, you may take the *Co-tang.* which is exactly the *Co-Arith.* of the double *Radius*, so that the *Tangent*, and *Co-tangent*, of an *Arch* makes exactly 20. 000000.

Now if the *Radius* be in the first place, then there is no need of taking the *Co-Arith.* of the first Number, only you must cut off, the first 1, to the left hand thus *x*, and you will have the *Logarithm* of the Number desired.

Thirdly, now to find the side AC, by the opposite Angle B; which is 93° 00′: (And seeing the Angle B, exceeds 90°, you must work by the *Complement* to 180°) as in the seventh Work in page 61 is taught.

§. 3.

	Co-Arith.
As S. *V*. C. 37° 00′.	0. 22054.
To Log. cr. AB 30 *parts*	1. 47712.
Fig. 36. *So is* Sc. *V*. B. 87° 00′,	9. 99940.
To Log. cr. AC $49\frac{78}{100}$ *parts*.	11. 69706.

Thus having found all the parts of the *Triangle* propounded, *Viz*. The Angle B, to be 93° 00′, the ſide AC to be $49\frac{78}{100}$ parts, and the ſide BC to be $38\frac{19}{100}$ parts, as was required to be found.

PROP. II.

Two ſides, and an Angle oppoſite to one of them in an Oblique-angled Triangle given, to find the other parts thereof.

In the Triangle ABC, the ſide AB is 30 parts, and the ſide AC, is $49\frac{78}{100}$ parts, and the oppoſite Angle C, is 37° 00′.

Fig. 36. *Firſt*, To find the Angle at B, this is the *Analogy* or *Proportion*.

As Log. cr. AB 30 *parts*,
To S. *V*. at C 37° 00′.
So Log. cr. AC $49\frac{78}{100}$ *parts*,
To Sc. *V*. B 93° 00′, *as was required to be found*.

Now ſeeing that the Angle C, is 37° 00′, and the Angle B, is 93° 00′, which makes 130° 00′, therefore muſt the Angle A be 50° 00′; the

Com-

Complement to 180° : so having found all the three Angles, you may find the other side CB, $38\frac{19}{100}$ parts, as afore in the first proposition, by his opposite Angle. §. 3. Fig. 36.

PROP. III.

Two Sides of an Oblique-angled Triangle, with the Angle included between them given, to find the other parts thereof.

In the Triangle ABC, the side AC is $49\frac{78}{100}$ parts, the side DB is 30 parts, and the Angle A between them is 50° 00′ ; and 'tis required to find the other parts of the Triangle propounded. To resolve this Conclusion, let fall a *Perpendicular* DB, from the Angle B, on the side AC ; (by prop. 3. §. 1. chap. 4.) and then proceed thus.

First, Seeing the *Oblique-angled Triangle*, ABC is divided into two *Rectangled Triangles*, *Viz.* ADB, and BDC: Now I will begin with the Triangle ADB, in which is given the Angle A 50° 00′, and the Angle D is a right Angle, or 90°, and the side AB 30 parts, and the sides AD, and DB, and the Angle at B, are required. Fig. 37.

First to find the Angle at B, remember that it is the *Complement* unto the Angle A 50° 00′, unto 90° 00′, and therefore must the Angle B be 40° 00′ ; Now for to find the *Cathetus* BD, (as in prop. 1. and 2. §. 2. chap. 5.) by the Rule of opposition, the *Analogy* or *Proportion* holds thus.

§. 3. *As Radius* or S. 90°,
To Log. Hypoth. AB 30 *parts.*
So S.*V.* at A 50° 00′,
To Log. Cath. BD $22\frac{98}{100}$ *parts sought.*

And AGAIN, say.

As Radius or S. 90°,
To Log. Hypoth. AB 30 *parts.*
So S.*V. at* B 40° 00′,
To Log. Base AD $19\frac{28}{100}$ *parts sought.*

Thus in the Triangle ADB, you have found the *Angle* B, to be 40° 00′, the *Cathetus* BD, to be $22\frac{98}{100}$ parts; and the *Base* AD to be $19\frac{28}{100}$ parts, as was so required.

Now for the other Triangle which is BDC, in which there is given the side BD, $22\frac{98}{100}$ parts, and the Angle at D, is a *Right-angle*, or 90°, and the sides DC, and CB, and the Angles B, and C, are required.

Fig. 37. First to find the side DC, substract AD, $19\frac{28}{100}$ parts, out of AC, $49\frac{78}{100}$ parts; there remains the *Base* DC; $30\frac{50}{100}$ parts: Thus have you the two sides of the Triangle, to wit the *Base* DC, $30\frac{50}{100}$ parts, and the *Cathetus* BD, $22\frac{98}{100}$ parts, and the Angle D between them is a *Right-angle* or 90°. Now you may find the Angle at B, by the *Tangent* (as in prop. 3. §. 2. chap. 5.) thus.

As Log. Cath. BD, $22\frac{98}{100}$ parts,
To Radius or S. 90°.
So Log. Base CD $30\frac{50}{100}$ parts.
To T.*V.* B. 53° 00′.

Secondly, For the Angle C, remember 'tis the *Complement* of the Angle B, 53°, to 90°; and therefore is the Angle C, 37° 00′, required.

Thirdly,

Thirdly, To find the *Hypoth.* BC, this is the *Analogy* or *Proportion*. §. 3.

As S *V*. B 53° 00′,

To Log. Base DC $30\frac{50}{100}$ parts.

So Radius or S. 90°,

To Log. Hypoth. BC $38\frac{19}{100}$ parts: Thus have you found all the required parts of the Triangle ABC propounded, *viz.* the Angle C to be 37° 00′, the Angle B, to be 93° 00′, * and the *Side* BC, $38\frac{19}{100}$ parts, as required to be found.

* *That is equal unto the two Angles B* 40° *and B.* 53° *as afore in the former Proposition.*

Another way to perform the same.

Take the Sum of the two sides, and the difference of the two sides; and work as followeth.	Side.	AB	$30\frac{00}{100}$
Now to find the two Angles B, and C, this is the Manner, and by this *Analogy* or *Proportion*,	Side.	AC	$49\frac{78}{100}$
	Sum.		$79\frac{78}{100}$
	Difference.		$19\frac{78}{100}$

Fig. 37.

they are found out and known.

As Log. Z. crs. AB, and CA, $79\frac{78}{100}$ *parts*,

To Log. X. crs. AB, and CA; $19\frac{78}{100}$ *parts*,

So T. *of* ½ *VV unknown*, 65° 00′,

To T. ½X. of *VV*, 28° 00′.

This difference of Angles 28° 00′, add unto 65° 00′, (half the difference of the unknown Angles) and it shall produce 93° 00′, which is the greater Angle, and substracted from it, leaves 37° 00′, which is the lesser Angle C: so have you the required Angles.

§. 3.

PROP. IV.

The three sides of an Oblique-angled Triangle given, to find the Angles.

In the Triangle ABC, the side AC, is $49,\frac{78}{100}$ parts, the side AB, is 30 parts, and the side BC, is $38,\frac{19}{100}$ parts; and the three Angles of the Triangle are required.

Side.	AB	$30,\frac{00}{100}$
Fig. 37. Side.	BC	$38,\frac{19}{100}$
Sum.		$68,\frac{19}{100}$
Diff.		$08,\frac{19}{100}$

The resolution of this Conclusion is thus. Take the *Summ* and *Differ.* of the two sides AB, and BC; And then work as follows: To find a *Segment* of the *Base* AC, to wit CE; say:

As Log. Base AC, $49,\frac{78}{100}$ *parts,*
To Z. cr^s. AB, and BC; $68,\frac{19}{100}$ *parts,*
So X. cr^s. AB, and BC; $8,\frac{19}{100}$ *parts,*
To Log. of a Segment of the Base AC, *to wit* CE $11,\frac{22}{100}$ *parts.*

This *Segment* of the *Base* CE, $11,\frac{22}{100}$ parts, being substracted from the whole *Base* AC, $49,\frac{78}{100}$ parts, the remainder is EA $38,\frac{56}{100}$ parts, in the middle of which as at D, the Perpendicular DB, will fall from the Angle B; and so divide it into two *Rectangled Triangles*, to wit, ADB, and CDB, whose Base DA is $19,\frac{28}{100}$ parts, which taken from AC $49,\frac{78}{100}$ parts, leaves the Base of the greater Triangle CD $30,\frac{50}{100}$ parts.

Fig. 37.

Now having the two *Bases* of these two *Triangles*, and their *Hypothenuses*; to wit CD $30,\frac{50}{100}$ parts, DA $19,\frac{28}{100}$ parts, CB $38,\frac{19}{100}$ parts, and BA 30 parts,

parts;you may find all their Angles,by the Rule of Opposite sides, to their Angles as afore. §. 3.

I. *In the Triangle* CDB.

To find the *Angles*, this is the *Analogy* or *Proportion*.

As Log. BC $38\frac{19}{100}$ parts,
To Radius or S. 90°.
So Log. DC $30\frac{50}{100}$ parts,
To S. *V*. B 53° 00′: *whose Complement* is the Angle at C 37° 00′ unto 90: or a *Quadrant*. Fig. 37.

II. *In the Triangle* ADB.

To find the Angles, this is the *Analogy* or *Proportion*.

As Log. AB, 30 *parts*,
To Radius or S. 90°.
So Log. AD $19\frac{28}{100}$ *parts*,
To S. *V*. B, 40° 00′.

The *Complement* whereof, unto 90° 00′, is the *Angle* at A 50° 00′.

Now in the first Triangle CDB, there is found the Angle C, to be 37° 00′, and the Angle B, to be 53° 00′.

In the second Triangle ADB, there is found the Angle A; to be 50° 00′, and the Angle B, to be 40° 00′.

Now the two Angles at B, to wit 53° 00′; and 40° 00′; makes 93° 00′, which is the Angle of the *Oblique-angled Triangle* ABC, at B: Thus the three Angles of the said given *Triangle* ABC, are found as was required, *viz*. the Angle A to be 50° 00′, the Angle B to be 93° 00′, and the Angle C to be 37° 00′, as sought.

Thus

§. 3. Thus I have ſufficiently, fully and plainly explained all the Caſes of *Plain Right-lined Triangles*, both *Right* and *Oblique-angled* : I ſhall now fall in hand with *Spherical Triangles*, both *Right* and *Oblique-angled.*

---

§. 4.

SECT. IV.

Of Spherical Rectangled Triangles.

And here firſt it will be neceſſary alſo to underſtand thoſe few general Maxims or Rules, that are of ſpecial Moment, in the Doctrine of Spherical Triangles.

1. THat a *Spherical Triangle* is comprehended and formed, by the Conjunction and Interſection of three *Arches* of a *Circle*, deſcribed on the *Surface* of the *Sphere* or *Globe*.

2. That thoſe *Spherical Triangles*, conſiſteth of ſix diſtinct parts, *viz.* three Sides and three Angles, any of which being known, the other is alſo found out and known.

3. That the three Sides of a *Spherical Triangle*, are parts or *Arches* of three great Circles of a *Sphere*, mutually interſecting each other : and as plain or Right-lined Triangles, are meaſured by a Meaſure, or *Scale* of equal parts : So theſe are meaſured, by a *Scale* or *Arch* of equal *Degrees*.

4 That

4. That a *Great Circle* is such a Circle that doth bessect the *Sphere*, dividing it into two equal parts; as the *Equinoctial*, the *Ecliptick*, the *Meridians*, the *Horizon*, &c. §. 4.

5. That in a *Right-angled Spherical Triangle*, the Side subtending the Right-angle we call the *Hypothenuse*, the other two containing the Right-angle we may simply call the *Sides*, and for distinction either of them may be called the *Base* or *Perpendicular*.

6. That the Summ of the Sides of a *Spherical Triangle* are less than two *Semicircles* or 360°.

7. That if two Sides of a *Spherical Triangle* be equal to a *Semicircle*; then the two Angles at the *Base* shall be equal to two Right-angles; but if they be less, then the two Angles shall be less; but if greater, then shall the two Angles be greater than a *Semicircle*.

8. That the Summ of the Angles of a *Spherical Triangle*, is greater than two *Right-angles*.

9. *That every spherical Triangle* is either a *Right*, or *Oblique-angled Triangle*.

10. That the *Sines* of the Angles, are in proportion, unto the *Sines* of their opposite Sides; and the *Sines* of their opposite Sides, are in proportion unto the *Sines* of their opposite Angles.

11. That in a *Right-angled Spherical Triangle*, either of the *Oblique-angles*, is greater than the *Complement* of the other, but less than the *Difference* of the same *Complement* unto a *Semicircle*.

12. That a *Perpendicular* is part of the *Arch* of a *great Circle*, which, being let fall from any Angle of a *spherical Triangle*, cutteth the opposite Side of the *Triangle* at *Right-angles*, and so divideth

§. 4. divideth the *Triangle* into two *Right-angled Triangles*, and theſe two parts (either of the Sides or Angles) ſo divided muſt be ſometimes added together, and ſometimes ſubſtracted from each other, according as the *Perpendicular* falls within or without the Triangle.

PROP. I. Caſe 1.

A Side and an Angle adjacent thereunto being given, to find the other Side.

In the Triangle ABC, there is given the Side AB 27° 54′; and the Angle A 23° 30′, and the Side BC is required, to find which this is the *Analogy* or *Proportion.*

As the Radius or S. 90° 00′,——10. 00000

To S, of cr. AB. 27, 54——9. 67018

Fig. 38. *So is* T. *V*.A, 23,30.——9. 63830

To cr. BC. 11, 30.——19. 30848

PROP. II. Caſe 2.

A Side and an Angle adjacent thereunto being given, to find the other Oblique-angle.

In the Triangle ABC, there is given the Fig. 38. Side AB 27° 54′, and the Angle A 23° 30′, and the Angle at C is required, to find which ſay by this *Analogy* or *Proportion.*

As the Radius or S. 90° 00′,

To Sc. *of* cr. AB 27, 54.

So

So is S. *V.* at A 23, 30, §. 4.
To Sc. *V.* at C 69, 22 required.

PROP. III. Case 3.

A Side and an Angle adjacent thereunto being given, to find the Hypothenuse.

In the Triangle ABC, there is given the Side AB 27° 54′, and the Angle at A 23° 30′, and the *Hypothenuse* AC, is required; which may be found by this *Analogy* or *Proportion.* *Fig.* 38.

As the Radius or S. 90° 00′,
To Sc. of *V.* at A 23, 30.
So is Tc. cr. AB, 27, 54.
To Tc. *Hypothenuse* AC, 30, 00 required.

PROP. IV. Case 4.

A Side and an Angle opposite thereunto being given, to find the other Oblique-angle.

In the Triangle ABC, there is given the Side BC 11° 30′, and the Angle A 23° 30′, and the Angle C is required, to find which, say by this *Analogy* or *Proportion.* *Fig.* 38.

As Sc. cr. BC, 11° 30′,
To Radius or S. 90,00.
So is Sc. *V.* at A, 23, 30,
To S. *V.* at C. 69, 22, as required.

PROP.

§. 4.

PROP. V. Case 5.

A Side and the opposite Angle given, to find the Hypothenuse.

Fig. 38. In the Triangle ABC, there is given the side BC 11° 30′, and the Angle at A 23° 30′, and the *Hypothenuse* AC, is required, which may be found by this *Analogy* or *Proportion.*

As S. *V.* at A 23° 30′,
To Radius or S. 90, 00.
So is Ser. BC 11. 30,
To S. *Hypothenuse* AC 30, 00. as required.

PROP. VI. Case 6.

A side and the opposite Angle given, to find the other side.

In the Triangle ABC, there is given the side BC 11° 30′, and the Angle at A 23° 30′, and the side AB is required, to find which this is the *Analogy* or *Proportion.*

Fig. 38. *As Radius* or S 90° 00′,
To Tc. of *V.* at A. 23 30,
So is T. cr. BC 11, 30,
To S. of cr. AB 27. 54 as was required.

PROP. VII. Case 7.

The Hypothenuse, and an Oblique Angle given, to find the side adjacent thereunto.

In the Triangle ABC, there is given the *Hypo-*

Hypothenuse AC, 30° 00′, and the Angle A 23° 30′, and the side AB, is required, which is found by this *Analogy* or *Proportion*. §. 4

As the Radius or S. 90° 00′, *Fig.* 38.
To Sc. *V.* at A, 23, 30.
So is T. *Hypoth.* AC, 30, 00,
To T. cr. AB, 27, 54, as was required.

PROP. VIII. Case 8.

The Hypothenuse, and an Oblique-angle given, to find the opposite Side.

In the Triangle ABC, there is given the *Hypothenuse* AC, 30° 00′, and the Angle at A 23° 30′, and the Side BC, is required, which is found by this *Analogy* or *Proportion*. *Fig.* 38.
As the Radius or S. 90° 00′,
To S. *Hypoth.* AC, 30, 00.
So is S. *V.* at A, 23, 30,
To the S. cr. BC, 11, 30. which was required.

PROP. IX. Case 9.

The Hypothenuse, and an Oblique-angle given, to find the other Oblique-angle.

In the Triangle ABC, there is given the *Hypothenuse* AC 30° 00′, and the Angle A, 23° 30′, now the Angle at C, is required, which may be found by this *Analogy* or *Proportion*.
As the Radius or S. 90° 00′,
To Sc. *Hypoth.* AC, 30,00.
So is T. of *V.* at A, 23, 30, *Fig.* 38.
To Tc. of *V.* at C. 69, 22, as was required.

PROP.

§. 4.

PROP. X. Case 10.

The sides given, to find the Hypothenuse.

In the Triangle ABC, there is given the side AB 27° 54′, and the side BC 11° 30′, and the *Hypothenuse* AC is required, to find which say by this *Analogy* or *Proportion.*

Fig. 38. *As the Radius* or S. 90° 00′,
To Sc cr. BC. 11, 30.
So is Sc. cr. AB 27, 54,
To Sc. *Hypothenuse* AC 30, 00. required.

PROP. XI. Case 11.

The sides given, to find an Angle.

In the Triangle ABC, there is given, the side AB 27° 54′, and the side BC 11° 30′, and the Angle at A, is required, which may be found by this *Analogy* or *Proportion.*

Fig. 38. *As the Radius* or S. 90° 00′,
To S. cr. AB. 27, 54.
So is Tc. cr. BC. 11, 30,
To Tc. of *V.* at A. 23. 30. as required.

PROP. XII. Case 12.

The Hypothenuse, and a side given, to find the other side.

Fig. 38. In the *Triangle* ABC, there is given, the *Hypothenuse* AC 30° 00′, and the side AB 27° 54′, and the side BC is required, which may be found

found by this *Analogy* or *Proportion*. §. 4.

As Sc. cr. AB. 27° 54′,
To Radius or S. 90 00.
So is Sc. *Hypothenuse* AC. 30° 00′,
To Sc. cr. BC. 11° 30′ as required.

PROP. XIII. Case 13.

The Hypothenuse, and a Side given, to find the contained Angle.

In the *Triangle* ABC, there is given the *Hypothenuse* AC 30° 00′, and the side AB 27° 54′, and the Angle at A is required, which may be found by this *Analogy* or *Proportion*. *Fig.* 38.

As the Radius or S. 90° 00′,
To T. cr. AB. 27° 54′.
So is Tc. *Hypoth.* AC 30° 00′,
To Sc. of *V.* at A, 23° 30′, as required.

PROP. XIV. Case 14.

The Hypothenuse, and a Side given, to find the opposite Angle.

In the *Triangle* ABC, there is given the *Hypothenuse* AC 30° 00′, and the side AB 27° 54′, now the Angle C, is required, which may be found by this *Analogy* or *Proportion*. *Fig.* 38.

As the S. *Hypoth.* AC, 30° 00′,
To Radius or S. 90° 00′.
So is S. *of* cr. AB, 27° 54′,
To S. of *V.* at C. 69 22, as required.

G PROP.

§. 4.

PROP. XV. Case 15.

The Oblique Angles given, to find either Side.

In the *Triangle* ABC, there is given the Angle A 23° 30′, and the Angle at C 69° 22′, and the side BC, is required, which may be found by this *Analogy* or *Proportion.*

Fig. 38. *As the* S. of *V.* at C, 69° 22′,
To the Radius or S. 90° 00′.
So is the Sc. of *V.* at A, 23° 30′,
To the Sc. *of* cr. BC, 11° 30′, as required.

PROP. XVI. Case 16.

The Oblique-angles given, to find the Hypothenuse.

In the *Triangle* ABC, there is given the Angle A 23° 30′, the Angle C, 69° 22′, and the *Hypothenuse* AC, is required, which may be found by this *Analogy* or *Proportion.*

Fig. 38. *As the Radius* or S. 90° 00′,
To Tc. of *V.* at C. 69°, 22′,
So is Tc. of *V.* at A, 23 30,
To Sc. *Hypoth.* AC, 30 00, as required.

SECT.

SECT. V. §. 5.

Of Oblique-angled Spherical Triangles.

PROP. I. Case 1.

Two Sides, and an Angle opposite to one of them given, to find the other opposite Angle.

IN the *Triangle* ADE, there is given the Side AE, 70° 00′, the Side ED, 38° 30′, and the Angle A, 30° 28′, now the Angle at D, is required, to find which this is the *Analogy* or *Proportion*. Fig. 39.

As S. cr. DE, 38° 30′,
To S. *V.* at A, 30 28.
So is S. cr. AE, 70 00,
To S. *V.* at D, 130 03, required.

☞ *Note that in these Operations, for the more facility of the learner, I omit* Seconds, *which doth belong unto the* Angles, *&c.*

PROP. II. Case 2.

Two Angles and a Side opposite to one of them given, to find the Side opposite to the other.

In the *Triangle* ADE, there is given the Angle at D, 130° 03′, the Angle E, 31° 34′, and the Side AE, 70° 00′, now the Side AD, is required, which may be found by this *Analogy* or *Proportion*. Fig. 39.

§. 5. *As* S. *V*. at D, 130° 03′,
To S. cr. AE, 70 00.
So is S. *V*. at E, 31 34,
To S. cr. AD. 40 00, required.

PROP. III. Case 3.

Two Sides and an Angle included between them being known, to find the other Angles.

Fig. 39. In the *Triangle* ADE, there is given the Side AE, 70° 00′, the Side AD, 40° 00′, and the Angle A 30° 28′, Now the Angles D, and E, are required, which is thus found: take the *Sum* and *Difference* of the two *Sides*, and work as followeth, saying.

Side. AE, 70° 00′,
Side. AD, 40 00

Sum.	110 00	½ Z. 55° 00′.
Diff.	30 00	½ X. 15 00.
Angle.	A, 30 28	½ *V*. 15 14.

As S. ½ *Z*. crs. AE and AD, 55° 00′,
To S. ½ X. crs. AE and AD, 15 00.
So is Tc. ½ *V*. at A, 15 14,
To T. ½ X. *VV*. D and E. 49 14 30″.

☞ *And here observe that if the Sum of the two contained Sides exceed a* Semicircle, *then substract each side severally from* 180°, *and proceed with those* Complements, *as with the sides given, the Operation produceth the* Complements *of the* Angles *sought, unto a* Semicircle *or* 180 Degrees.

Again.

§. 5.

A G A I N.

As Sc. ½ Z. crs. AE and AD, 55° 00′,
To Sc. ½ X. crs. AE and AD, 15° 00′.
So is Tc. ½ *V*. at A, 15° 14′,
To T. ½ Z. *VV*. D and E, 80 48 30″.

This difference of the Angles unknown D and E, 49° 14′ 30″, being added unto the half Sum of the Angles 80° 48′ 30″, (unknown) produceth the Greater Angle D 130° 03′, and substracted from it, leaves the Lesser Angle E, to wit 31° 34′.

PROP. IV. Case 4.

Two Angles, and their Interjacent side being known, to find the other sides.

In the *Triangle* ADE, there is given the Angle at A 30° 28′, and the Angle at D 130° 03′, and their *Interjacent-side* AD 40° 00′, and the Sides DE and EA, are required: Which is thus found. *Fig.* 39.

Take the *Sum* and *Difference* of the two *Angles*, and work as followeth, saying.

☞ *And here observe that if the Sum of the two given Angles excede a* Semicircle *or* 180°, *substract them from a* Semicircle, *and proceed with the Residues, the Operation will produce each side's* Complement *to a* Semicircle, *or* 180 Degrees.

§. 5. *Angle.* D 130° 03′.
Fig. 39. *Angle* A, 30 28.

Sum.	160 31	}	$\frac{1}{2}$ Z. is 80° 15′ 30″
Diff.	99 35	}	$\frac{1}{2}$ X. is 49 47 30
Side. AD,	40 00	}	$\frac{1}{2}$ cr. is 20 00 00.

As S. $\frac{1}{2}$ Z. *of VV.* A and D, 80° 15′ 30″,
To S. $\frac{1}{2}$ X. *of VV.* A and D, 49 47 30.
So is T. $\frac{1}{2}$ cr. AD, 20 00 00,
To T. $\frac{1}{2}$ X. cr^s. DE and EA, 15 45 00.

AGAIN Say.

As Sc. $\frac{1}{2}$ Z. *of VV.* A and D, 80° 15′ 30″,
To Sc. $\frac{1}{2}$ X. *of VV.* A and D, 49 47 30.
So is T. $\frac{1}{2}$ cr. AD, 20 00 00,
To T. $\frac{1}{2}$ cr^s. Z. DE and AE. 54 15 00.

Add the half Difference of the Sides DE and AE, 15° 45′, unto half the Sum of the Sides DE and AE, 54° 15′. It produceth the greater Side, the Side AE 70° 00′, but if deducted from it, leaves the lesser Side ED, which is 38° 30′, as was required.

PROP.

§. 5.

PROP. V. Case 5.

Two Sides and an Angle opposite to one of them given, to find the third side.

In the *Triangle* ADE, there is given the Side AE 70° 00′, the Side DE 38° 30′, and the Angle A 30° 28′, the Side AD is required. Fig. 39.

First by *Case* 1. *Prop.* 1. I find the Angle at D to be 130° 03′, and then proceed thus

First take the *Sum* and *Difference* of the two *Angles*; then also find the *Difference* of the two Sides given, and then work as followeth.

Angle D,	130° 03′,		
Angle A,	30 28.		
Sum	160 31	}	½ Z 80° 15′ 30″.
Differ.	99 35	}	½ X. 49.47 30.

Side.	AE	70 00.		
Side.	ED	38 30		
Diff.		31 30.	}	½ X. 15° 45′.

Now say,

As S. ½ X. *VV.* D and A, 49° 47′ 30″,
To S ½ Z. *VV.* D and A, 80 15 30.
So is T. ½ X. cr^s. AE and ED, 15 45 00,
To T. ½ cr. AD. 20° 00′ 00″: which doubled giveth the Side AD, 40 00 00, as was required.

§. 5.

PROP. VI. Case 6.

Two Angles and a Side opposite to one of them given, to find the third Angle.

Fig. 39. In the *Triangle* ADE, there is given the Angle A 30° 28′, the Angle D 130° 03′, and his opposite Side AE 70° 00′; and 'tis required to find the Angle at E.

First by *Prop. 2. Case 2.* I find the Side DE, opposed to the Angle A; to be 38° 30′, then proceed thus.

First find the *Sum* and *Difference* of the *Sides*. Then find the *Difference* of the *Angles*.

Side. DE	38° 30′,	
Side. AE	70 00	
Sum.	108 30	½ Z. 54° 15′.
Differ.	31 30	½ X. 15 45.

Angle D	130 03	
Angle A	30 28	
Differ.	99 35	½ X. 49° 47′ 30″.

Now say,

As S. ½ X. cr^s. DE and AE 15° 45′,
To S. ½ Z. cr^s. EA and DE 54 15.
So is T. ½ X. *V^s*. D and A 49 47 30″,
To Tc. ½ *V*. at E. 15° 47′ 00″. which doubled giveth the Angle at E 31 34, as required.

PROP.

§. 5

PROP. VII. Case 7.

Two Sides and an Angle opposite to one of them given, to find the Included Angle.

In the *Triangle* ADE, there is given the Side AE 70° 00′, the Side ED 38° 30′, and the Angle opposite thereunto at A 30° 28′, and the Angle E is required. *Fig.* 39.

First by *Prop.* 1. *Case* 1. I find the Angle D, opposite to AE, to be 130° 03′, then proceed thus.

First find the *Difference* of the *Angles*, then find the *Sum* and *Difference* of the *Sides*.

Angle D	130° 03′	
Angle A	30 28	
Differ.	99 35	$\frac{1}{2}$ X. 49° 47′ 30″.

Side AE	70° 00′	
Side ED	38 30	
Sum	108 30	$\frac{1}{2}$ Z. 54° 15′.
Differ.	31 30	$\frac{1}{2}$ X. 15 45.

Now say,

As S. $\frac{1}{2}$ X. cr^s^. AE and ED 15° 45′,
To S $\frac{1}{2}$ Z. cr^s^. AE and ED 54 15.
So is T. $\frac{1}{2}$ X. of *VV*. D and A 49 47 30″, *Fig.* 39.
To Tc. $\frac{1}{2}$ *V*. at E 15° 47′. Which doubled is the Angle at E 31° 34′, as was required.

PROP.

§. 5.

PROP. VIII. Case 8.

Two Angles and a Side opposite to one of them being known, to find the Interjacent Side.

In the *Triangle* ADE, there is given the Angle E 31° 34′, the Angle D 130° 03′, and his opposite Side AE 70° 00′, Now the Side ED is required.

First by *Prop.* 2. *Case* 2. I find AD opposed to E, to be 40° 00′, and then work thus.

Take the *Sum* and *Difference* of the *Angles*, then ~~also~~ find the *Difference* of the two *Sides*:

Fig. 39.

Angle D	130°	03′	
Angle E	31	34	
Sum	161	37	½ Z. 80° 48′ 30″
Differ.	98	29	½ X. 49° 14′ 30″

Side AD	40°	00′	
Side AE	70	00	
Differ.	30	00	½ X. 15° 00′

Now say,

As S. ½ X. *VV* D and E 49° 14′ 30″,
To S. ½ Z *VV* D and E 80 48 30.
So is T ½ X crs. AD and AE 15 00 00″,
To T. ½ crs. ED, 19° 15′ 00″, which being doubled is the Side ED 38° 30′, as required.

PROP.

§. 5.

PROP. IX. Case 9.

Two Sides and their Included Angle being known, to find the third Side.

In the *Triangle* APZ, there is given the Side ZP 38° 30′, the Side PA 70°, and the Angle P, let be 31° 34, and the Side AZ is required. *Fig.* 40.

The Resolution of this Case depends on the *Catholike proposition* of the *Lord of Marchiston*, by supposing the *Oblique-Triangle* to be divided (by a supposed *Perpendicular* falling either within or without the *Triangle*) into two *Rectangulars*.

Now in the *Triangle* AZP, let fall the *Perpendicular* ZR; so is the *Triangle* AZP divided into two *Rectangulars* ARZ and ZRP. Now the Side AZ may be found at two *Operations* thus: say,

As the Radius or S. *of*	90°	00′
To Sc. *of the included* ∨, P.	31	34.
So is T. *of the lesser Side* PZ.	38	30,
To T. *of a fourth Arch.*	34	08.

If the *contained Angle* be less than 90°, take this *fourth Arch* from the *greater Side*; but if it be greater than 90°, from its *Complement* unto 180°, the Remainder is the *Residual Arch*: Now again say,

As Sc. *of the fourth Arch.*	34°	08′
To Sc. *Residual Arch.*	35	52.
So Sc. *of the lesser Side* PZ.	38	30
To Sc. AZ *the Side required.*	40	00

☞ But

§. 5. ☞ But note that many times the *Perpendicu-*
Fig. 41. *lar* will fall without the *Triangle*, as it doth now within; in such case the Sides of the *Triangle* must be continued, so will there be two *Rectangulars*, the one included within the other: as in the *Triangle* HIK, the *Perpendicular* let fall is KM, falling on the Side HE, and so the two *Rectangulars* found thereby will be IMK, and KMH, and so by the directions in the former proposition find out the Side IK, if required to be found.

☞ *Note that if the Angles at the* Base *be both of one kind, that then the* Perpendicular *falls within the* Triangle: *if of diverse kinds, without the* Triangle.

PROP. X. Case 10.

Two Angles and their Interjacent Side known, to find the third Angle.

In the *Triangle* AZP, there is given the Side ZP 38° 30′, the Angle P 31° 34′, and the Angle Z 130° 03′, and the Angle at A is required

First the *Oblique-Triangle* AZP, being redu-
Fig. 40. ced into two *Rectangulars* ARZ, and ZRP, by *Case* 9 *aforegoing*, I find the Angle RZP, to be 64° 19′, (in the *Triangle* ZRP.) which taken out of Angle AZP 130° 03′, leaves the Angle AZR 65° 44′: Now the Angle A is found by this *Analogy* or *Proportion*.

As S. *V*. PZR, 64° 19′,
To S. *V*. AZR 65 44,
So is Sc. *V*. at P 31 34,
To Sc. *V*. *at* A 30 28: which was required to be found out and known.

PROP.

§. 5.

PROP. XI. Case II.

Three Sides given, to find an Angle.

In the *Triangle* APZ, the Side AZ is 40° 00′, the Side ZP is 38° 30′, the Side AP is 70° 00′, and the Angle Z is required. To find which do thus.

Add the three Sides together, and from half their Sum, deduct the Side opposite, to the required Angle: and then proceed as you see in the Operation following. *Fig.* 40.

Side AP	70° 00′		*Co-Arith.*
Side AZ	40 00	————————	0, 191933
Side ZP	38 30	————————	0, 205850
Sum	148 30		Sines.
½ *Sum*	74 15	————————	9, 983380
Side AP	70 00		
Rem.	04 15	————————	8, 869868
Sum is		————————	19, 251031

Fig. 40.

½*Sum* is 65° 07′ 30″, the Sc. ½ *V*. at Z, 9, 625515 which doubled is 130° 03′ 12″; the ———— Angle at Z required.

PROP.

§. 5.

PROP. XII. Case 12.

Three Angles given, to find a Side.

Fig. 40. In the *Triangle* AZP, the Angle A is 30° 28′ 11″, the Angle Z 130° 03′ 12″, the Angle P is 31° 34′ 26″, and the Side AZ, opposite to P, is required.

This *Case* is likewise performed as the former Case or Proposition, the Angles being converted into Sides, and the Sides into Angles, by taking the *Complement* of the greatest Angle unto 180°: see the work.

Angle E	31°	34′	26″	*Co-Arith.*
Angle A	30	28	11	0, 294920
Comp. V. Z	49	56	49	0, 116084
Sum is	111	59	26	Sines
½ *Sum is*	55	59	43	9, 918549
Angle P	31	34	26	
Differ.	24	25	17	9, 616417

Fig. 40.

Sum total ——— 19, 945970

The ½ *Sum is* Sc. *of* 20° 00′ *half the Side* AZ, ——— 9, 972985

which being doubled, gives the Side AZ 40° 00′, required to be found out and known.

☞ But if the greater Side AP were required, the Operation would produce the *Complement* thereof unto a *Semicircle* or 180°; therefore

substract

substract it from 180°, it leaves the remaining required Side sought. §. 5.

Thus I have laid down all the *Cases* of *Triangles*, both *Right-lined* and *Spherical*; either *Right*, or *Oblique-angled*; I might hereunto have annexed many Varieties unto each *Case*, and some fundamental *Axioms*, which somewhat more would have Illustrated and Demonstrated those *Cases*, and *Proportions*; but because of the smallness of this *Treatise*, which is intended more for *Practice* than *Theory*, I have for brevity sake omitted them, and refer you for those things to larger Authors, who have largely discoursed thereon to good purpose.

CHAP.

CHAP. VI.

Of ASTRONOMY.

Defin. ASTRONOMY *is an Art Mathematical, which measureth the distinct course of Times, Days, Years,* &c. *It sheweth the Distance, Magnitude, Natural Motions, Appearances and Passions, proper unto the Planets, and fixed Stars, for any time past, present and to come; by this we are certified of the Distance of the starry Sky, and of each Planet, from the Center of the Earth, and the Magnitude of any fixed Star or Planet, in respect of the Earth's Magnitude.*

§. 1. SECT. I.

Of Astronomical Definitions.

Defin. 1. A *Sphere or Globe* is a solid Body, containing onely one *Superficies*, in whose middle there is a point (called the *Center*;

Center,) from which all right or streight lines drawn unto the *Circumference* or *Superficies*; are Equal. §. 1.

2. *The Poles* of the World, are two fixed points in the *Heavens Diametrically* opposite the one to the other, the one called the *Artick* or *North-Pole*; noted in the *Scheme* by P. The other is called the *Antartick*, or *South-Pole*; as S. and is not to be seen of us, being in the lower *Hemisphere*. Fig. 42.

3. *The Axis* of the *World*, is an imaginary line drawn from the *North-Pole*, through the *Center* of the *Earth*, unto the *South-Pole*, about which the *Diurnal* motion is performed, from the *East* to the *West*; as the line PS Fig. 42.

4. *The Meridians* are great *Circles*, concurring and intersecting one another, in the *Poles* of the *World*, as PES, and Pc S. Fig. 42.

5. The *Equinoctial*, or *Equator*, is a great Circle, 90 deg. distant from the *Poles* of the *World*, cutting the *Meridians* at *Right-angles*, and divideth the *World* into two Equal parts, called the *Northern*, and *Southern Hemispheres*; as E ♎ Q. in *Scheme* 42. Fig. 42.

6. *The Eclíptick* is a great Circle, crossing the *Equinoctial*, in the two opposite points *Aries* and *Libra*, and maketh an Angle therewith (called, its *Obliquity*) of 23° 30′, represented by ♋ ♎ ♑. This *Circle* is divided into 12 *Sines*, each containing 30° 00′: *As Aries* ♈, *Taurus* ♉, *Gemini* ♊, *Cancer* ♋, *Leo* ♌, *Virgo* ♍, (which are called *Northern Sines*) *Libra* ♎, *Scorpio* ♏, *Sagitarius* ♐, *Capricornus* ♑, *Aquarius* ♒, and *Pisces* ♓; these are called *Southern Sines*. Fig. 42.

§. 1. 7. The *Zodiack* is a *Zone* or *Girdle*, having 8 deg. of *Latitude* on either side the *Ecliptick*, in which space the *Planets* make their revolution. This *Circle* is a Circle which regulates the *Years*, *Months*, and *Seasons*, * and is distinguished in the *Scheme* by the 12 *Sines*.

Fig. 42. * *Which is by the Greeks called* Ζῳδιακός, *i. e. bring Life; because the life of all Creatures depend on the cause of that Circle, for the Sun ascending in it and moving towards us, brings the Generation of things, and in descending the Corruption of all things sensible, and insensible, which are below the concavity of the Moon,* &c.

8. The *Colures* are two *Meridians*, dividing the *Ecliptick*, and the *Equinoctial*, into four equal parts; one of which passeth by the *Equinoctial* points *Aries*, and *Libra*, and is called the *Equinoctial Colure*, as P ♎ S. The other by the beginning of *Cancer*, and *Capricorn*, and is called the *Solstitial Colure*, as P ♋, S ♑.

Fig. 42.

9. The *Poles* of the *Ecliptick* are two points, 23° 30′ distant from the *Poles* of the *World*, as I and K

Fig. 42.

10. The *Tropicks* are two *small Circles*, *Parallel* unto the *Equinoctial*, and distant therefrom 23° 30′, limiting the *Sun's greatest declination*. The *Northern Tropick* passeth by the beginning of *Cancer*, and is therefore called the *Tropick of Cancer*, as ♋ a D. The *Southern Tropick* passeth by the beginning of *Capricorn*, and is therefore called the *Tropick* of *Capricorn*; as B b ♑.

Fig. 42.

11. The *Polar Circles*, are two small Circles *parrallel* to the *Equinoctial*, and distant therefrom 66° 30′; and from the *Poles* of the *World*

23°.

23°. 30′. That which is *adjacent* unto the *North Pole*, is called the *Artick Circle*, as G d I. and the other the *Antartick Circle*, as K d M. §. 1. Fig. 42.

12. The *Zenith*, and the *Nadir*, are two points, *Diametrically* opposite the one to the other: the *Zenith* is the *Vertical point*, or the point over our heads, as Z, The *Nadir*, is opposite thereto as the point N.

13. The *Azimuths* or *Vertical Circles* are great Circles of the *Sphere*, concurring and intersecting each other, in the *Zenith*, and *Nadir*, as Z f N.

14 The *Horizon*, is a great Circle, 90 deg. distant from the *Zenith*, and *Nadir*; cutting all the *Azimuths*, at Rightangles, and dividing the World into two equal parts, the upper and *visible Hemisphere*, and the lower and *invisible Hemisphere*, represented by H ≏ R. Fig. 42.

15. The *Meridian* of a *Place*, is that *Meridian*, which passeth by the *Zenith*, and *Nadir*, of the place as *P Z S N*. Fig. 42.

16. The *Almicanthars*, or *Parallels of Altitude*, are small Circles, parrallel unto the *Horizon*, imagined to pass through every degree and minute of the *Meridian*, between the *Zenith*, and *Horizon*, B a F.

17. *Parallels of Latitude*, or *Declination*, are small Circles parallel unto the *Equinoctial*; they are called *Parallels* of *Latitude*, in respect to any place on the *Earth*, and *Parallels* of *Declination*, in respect of the *Sun*, or *Stars*, in the *Heavens*. Fig. 42.

18. The *Latitude of a place*, is the height of the *Pole* above the *Horizon*; or the distance between the *Zenith* and the *Equinoctial*.

§. 1. 19. The *Latitude of a Star*, is the *Arch of a Circle*, contained betwixt the *Center of* a *Star*, and the *Ecliptick line*: this Circle making *Right-angles*, with the *Ecliptick*, is accounted either *Northward* or *Southward*; according to the Scituation of the *Star*.

20. *Longitude* on *Earth* is measured by an *Arch* of the *Equinoctial*, contained between the *Primary Meridian*, (or *Meridian* of that place where *Longitude* is assigned to begin) and the *Meridian* of any other place, counted always *Easterly*.

21. The *Longitude* of a *Star*, is that part of the *Ecliptick*, which is contained between the *Star's place* in the *Ecliptick*, and the beginning of *Aries*, counting them according unto the succession of *Sines*.

22. The *Altitude* of the *Sun* or *Stars*, is the *Arch* of an *Azimuth*, contained betwixt the *Center* of the *Sun*, or *Star*, and the *Horizon*.

23. *Ascension* is the rising of any *Star*, or part of the *Equinoctial*, to any degree above the *Horizon*; and *Descension* is the setting of it.

24. *Right Ascension*, is the number of *Degrees* and *Minutes* of the *Equinoctial*; (i. e. from the beginning of *Aries*) which cometh unto the *Meridian*, with the *Sun* or *Stars*; or with any portion of the *Ecliptick*.

25. *Oblique-Ascension*, is an *Arch* of the *Equinoctial*, between the beginning of *Aries*, and that part of the *Equinoctial* which riseth with the *Center* of a *Star*; or with any *portion* of the *Ecliptick* in an *Oblique Sphere*: and *Oblique Descention*, is that part of the *Equinoctial*, that setteth therewith.

26. The

26 The *Ascentional difference*, is an *Arch* of the *Equinoctial*, being the difference betwixt the *Right* and *Oblique-Ascension*. §. 1.

27. The *Amplitude*, of the *Sun* or *Stars*, is the distance of the rising or setting thereof, from the *East* or *West* point of the *Horizon*. *Fig.* 43.

28 The *Parallax*, is the difference between the *true* and *apparent* *place* of the *Sun* or *Star*; so the *true place* in respect of *Altitude*, is in the line ACE, or ADG, the *Sun* or *Star* being at C, or D, and the *apparent place* in the Line BCF, and BDH, so likewise the Angles of the *Parallax* are ACB, or ECF; and ADB, or GDB: also in the said *Scheme*, ABK represententh a *Quadrent* (of the *Globe* or *Earth*,) on the *Earth's Superficies*: A the *Center* of the *Earth*, and B any point of the *Earth's Surface*. *Fig.* 43.

29. The *Refraction* of a *Star*, is caused by the *Atmosphere*, or *Vapourous* thickness of the *Air* near the *Earth's Superficies*, whereby the *Sun* and *Stars* seem always to rise sooner, and and set later than really they do.

---

§. 2.

SECT. II.

Of Astronomical Propositions.

PROP. I.

The Distance of the Sun from the next Equinoctial point (either Aries *or* Libra*) being known, to find his Declination.*

THE *Analogy* or *Proportion.*

As Radius or S. 90°,
To S. *of the Sun's distance from the next Equinoctial point,*
So is S. *of the Sun's greatest Declination,*
To the S. *of the Sun's present Declination sought.*

PROP. II.

The Sun's place given, to find his Right-Ascension.

This is the *Analogy* or *Proportion.*

As Radius or S. 90°,
To T. of the Sun's Longitude from the next Equinoctial point,
So is the Sc. *of his greatest Declination,*
To T. of his Right-Ascension from the next Equinoctial point.

PROP.

§. 2.

PROP. III.

To find the Sun's place or longitude from Aries, *his Declination being given.*

This is the *Analogy* or *Proportion.*
As S. *of the Suns greatest Declination,*
To Radius or S.90° 00′,
So is S. *of his present Declination,*
To S. *of the Suns Place*
or Longitude from Aries *.

* *If the* Sun's Declination *be* North, *and increasing, this Proportion finds the* Sun's *distance from* ♈; *but if decreasing from* ♎ *in the northern* Sines. *But if the* Sun's Declination *be* South, *and increasing from* ♎; *if decreasing from* ♈, *among the* Southern Sines.

PROP. IV.

By knowing the Suns Declination, to find his Right Ascension.

This is the *Analogy* or *Proportion.*
As Radius or S. 90°,
To Tc. *of the Suns greatest Declination,*
So is T. *of the Declination given,*
To S. *of the Suns right*
Ascension required †.

† *From the next* Equinoctial *point either* ♈, *or* ♎.

§. 2.

PROP. V.

By knowing the Latitude of a Place, and the Suns Declination, to find the Ascensional Difference.

This is the *Analogy* or *Proportion.*
As Radius or S. 90°,
To Tc *of the Latitude given,*
So is T. *of the Suns Declination given,*
To the S. *of the Ascensional difference* required.

☞ Note that if you reduce the degrees, *&c.* of the *Ascensional difference* into hours, it will shew you how much the *Sun* riseth, or setteth before, or after six a Clock, in that Latitude.

PROP. VI.

To find the Suns Oblique Ascension or Descension.

First find the *Ascensional Difference* by the 5*th* Proposition, and his *Right-ascension* by the fourth: Now if the *Suns Declination* be Northerly, deduct the *Ascentional Difference* out of his *Right Ascension*, from the beginning of ♈, (for the six Northern Signs ♈♉♊♋♌♍) it leaves the *Oblique Ascension*; and added unto the *Right-ascension*, giveth the *Oblique-descension.*

But if the *Suns Declination* be *Southerly*, the *Ascentional Difference*, added to the *Right-ascension*, (for the six Southern Signs ♎♏♐♑♒♓) giveth the *Right-ascension*, and substracted therefrom leaves the *Oblique-descension.*

PROP.

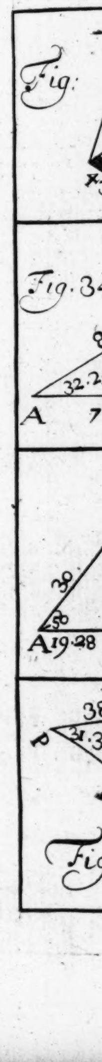

Plate II

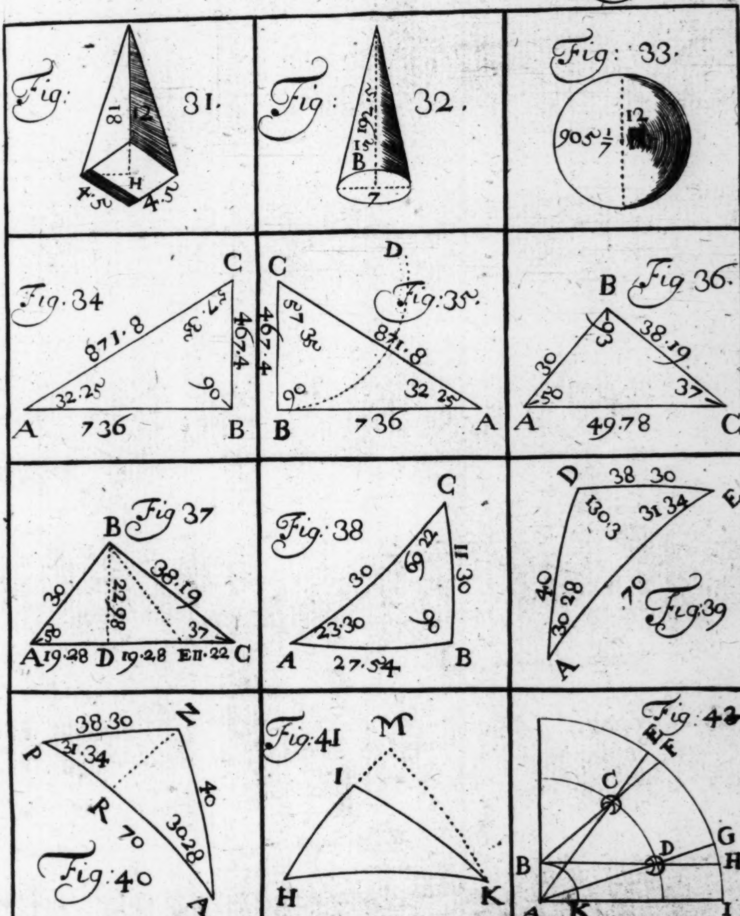
Fig: 31.
18
12
H
4.5
4.5
Fig: 32.
15
B
7
Fig: 33.
12
905 1/7
Fig. 34
C
871.8
467.4
32.25
90
A
736
B
C
D
Fig: 35.
467.4
871.8
90
32 25
B
736
A
B
Fig 36.
38.19
30
37
A
49.78
C
B
Fig 37
30
38.19
22.98
37
A 19.28
D 19.28
E 11.22
C
C
Fig: 38
30
11 30
90
23.30
A
27.54
B
D
38 30
E
31 34
130.3
40
30 28
70
Fig: 39
A
38 30
Z
P
31.34
40
R
70
30.28
Fig: 40
A
Fig: 41
M
I
H
K
Fig: 42
E
F
C
G
D
B
H
A
K
I

§. 2.

PROP. VII.

By knowing the Suns Declination, and the Latitude of a Place, to find the Suns Amplitude.

This is the *Analogy* or *Proportion.*
As Sc. *of the Latitude,*
To the Radius or S. 90°.
So is the S. *of the Suns Declination,*
To the S. *of the Amplitude* from the *East* or *West* Points of the *Horizon.*

PROP. VIII.

By knowing the Suns Declination and Amplitude, from the North part of the Horizon, to find the Latitude.

This is the *Analogy* or *Proportion.*
As Sc. *of the Amplitude* from the *North,*
To Radius or S. 90° 00′
So is S. of his *Declination* given,
To Sc. of the required *Latitude.*

PROP. IX.

By knowing the Latitude of a place, and the Sun's Declination, to find at what time the Sun will be on the true East or West Points.

The *Analogy or Proportion* is.
As T. of the given *Latitude,*
To. T. of the *Sun's Declination* propounded,
So is Radius or S. 90° 00′,
To Sc. of the *Hour* from *Noon.*

PROP.

§. 2.

PROP. X.

By knowing the Sun's Declination, and Latitude of a place, to find his Altitude at six a Clock.

This is the *Analogy* or *Proportion.*
As Radius or S. 90° 00′,
To S. of the *Sun's Declination,*
So is S. of the *Latitude of the place,*
To S. of the *Sun's Altitude* at six a Clock.

PROP. XI.

By knowing the Latitude of a place, and the Sun's Declination, to find the Azimuth at six.

This is the *Analogy* or *Proportion.*
As Radius or S. 90° 00′,
To the T. of the *Sun's Declination,*
So is Sc. of the *Latitude of the place,*
To the T. of the *Azimuth* sought.

PROP. XII.

By knowing the Latitude of a place, and the Sun's Declination, to find the Sun's Altitude when he is on the true East or West points.

This is the *Analogy* or *Proportion.*
As S. of *the Latitude,*
To the Radius or S. 90° 00′,
So is the S. of the *Declination,*
To the S. of the *Sun's Altitude* being due *East* or *West.*

PROP.

PROP. XIII.

To find the Sun's Altitude at any time of the day.

The *Analogy* or *Proportion*, is.
As Radius or S. 90° 00′,
To Tc. of the *Poles height*,
So is S. of the *Sun's Distance*,
From the Hour of Six,
To the T. of an *Arch*: which being substracted from the *Sun's Distance* from the *Pole*; say,
As Sc. of the *Arch found*,
To Sc. of the *remaining Arch* of the *Sun's Distance* from the *Pole*,
So is S. of the *Poles height*,
To the S. of the *Sun's Altitude* at the Hour required.

PROP. XIV.

By knowing the Latitude of a Place, with the Sun's Declination, and Altitude, to find the Hour of the Day.

To solve this Conclusion do thus: get the Sum of the *Complements* of the *Latitude*, *Declination* and *Altitude* given *, Then find the Difference betwixt their half Sum, and the *Complement* of the *Altitude*; then say,

* *As in Case* 11 *of Oblique Spherical Triangles.*

As Radius or S. 90° 00′,
To Sc. of the *Sun's Altitude*,
So is Sc. of the *Latitude* of the Place,

To

§. 2. *To a fourth Sine:* then again say,
As the fourth S.
To the S. of ½ Z. of the *Lat. Declin.* and *Alt.*
So is the S. of X. of the *Altitude* to the ½ Z,
To a fifth S. unto which *Sine*, if you add the *Radius* or 90° 00′, half that Sum shall be the *Sine* of an *Arch*, whose double *Complement* is the Hour from the *Meridian*.

PROP. XV.

To find the Time of the Sun's Rising or Setting, and consequently the Length of the Day or Night.

To resolve this *Conclusion*, first by prop. the 5 find the *Ascensional Difference*, which reduced into *Hours*, and *Minutes* of Time, by allowing for every 15 *Deg.* one *Hour*, and for every *Deg.* less than 15°, 4′, of Time, and for every 15 *Min.* one *Minute* of *Time*.

Secondly, If the *Sun's Declination* be Northerly, the *Ascentional Difference* added unto 6 Hours, gives the Time of *Sun-setting*, and substracted therefrom, leaves the Time of *Sun-Rising*: On the contrary, if the *Sun's Declination* be *Southerly*, the *Ascentional Difference* added unto 6 Hours, gives the Time of *Sun Rising*, and deducted therefrom, the Time of *Sun-setting*.

Thirdly, If you double the Time of *Sun-Rising*, it gives you the length of the *Night*; and the Time of *Sun-setting*, the length of the *Day*.

PROP.

§. 2.

PROP. XVI.

The Sun's Declination, Altitude and Azimuth known, to find the Hour of the Day.

The *Analogy* or *Proportion* is.
As the Sc. of the *Sun's Declination,*
To the S of the *Azimuth,*
So is the Sc. of the *Altitude,*
To the S. of the Hour from *Noon:* which converted into Time, will shew the Hour of the Day.

PROP. XVII.

By knowing the Sun's Declination, Altitude, and Hour from Noon, to find the Azimuth.

The *Analogy* or *Proportion* is.
As Sc. of the *Sun's Altitude,*
To S. of the *Hour from Noon,*
So is Sc. of the *Sun's Declination,*
To the S. of the *Azimuth,* required.

PROP. XVIII.

By knowing the Latitude of a place, the Altitude of the Sun, and the Hour from Noon, to find the Angle of the Sun's Position.

This is the *Analogy* or *Proportion.*
As Sc. of the *Sun's Altitude,*
To S of the *Hour from Noon,*
So is Sc. of the *Latitude,*

To

§. 2. *To* S. of the *V.* of the *Sun's Position*, at the time of the *Question.*

PROP. XIX.

By knowing the Sun's Altitude, Declination, and Azimuth; to find the Latitude.

The *Analogy* or *Proportion* is.
As S. of the *Sun's Azimuth*,
To S. of his *Distance from* the *North-pole*,
So is S. of *V* of the *Sun's Position*,
To Sc. of the *Latitude* required.

PROP. XX.

To find the length of the Crepusculum, or Twilight

The Crepusculum or *Twilight*, is nothing else but the *Refraction* of the *Sun's-Beams* in the *Density* of the *Air.* Which the Learned *Pet. Nonnius* found the length of the *Crepusculum* (by his many strict observations *) to continue from the time of the *Sun's* passing below the *Horizon* of a place, untill the *Sun* had run below the said *Horizon* 18° 00′, and then followed the shutting in of the *Twilight*, and untill the *Sun* was departed

* *Watched the Time after* Sun-setting *when the* Twilight *in the* West *was shut in, so that no more* Twilight *than in any other part of the* Skie *near the* Horizon *appeared there: then by one of the known* fixed Stars, *having found the true* Hour *of the* Night, *he*

departed so low the *Twilight* continued.--To find which observe this *Analogy* or *Proportion*.

found the length of the Twilight, *to be as in the rule is mentioned.* §. 2.

As Radius or S. 90°,
To Sc. of the *Sun's Declination*,
So is Sc. of the *Poles-height*,
To a fourth Sine : which keep.

Then out of the *Sun's Distance* from the *South-Pole*, subduct the *Complement* of the *Pole* ; and of that remains and the degrees 62, being added to it, their *Sum* and *Difference* found, say again.

As the fourth Sine found,
To S. ½ Z of the *remainder* and 62° 00′,
So is S. ½ X. of the *remainder* and 62° 00′,
To a Number, which being multiplyed by the *Radius* is equal unto the *Quadrat* of the *Sine* of the ½ *Angle* of the *Sun's Distance* at the Ending of the *Twilight*, from *Noon* next ensuing.

Then from the *Sun* of the whole *Angle* converted into *Hours*, substract the *Hour* of the *Sun's setting* *, it gives you the length of the *Crepusculum*, or *Twilight*.

* *Or* ½ *Diurnal Arch.*

But the *Sun* being in the *Winter Tropick*, makes the *Twilight* longest of any *Twilight*, the whole *Winter* half year: Now in a certain *Parallel*, betwixt that *Tropick*, and the *Equinoctial* is the shortest *Crepusculum :* the *Declination* of which *Parallel*, is thus found.

To find the length of the least Crepusculum *or* Twilight.

As the Tc. of the *Pole*,
To the S of the *Pole*,
So is the T. of 09° 00′,

To

§. 2. *To* S. of the *Declination* of the *Parallel*, in which the *Sun* maketh the shortest *Crepusculum* of the Year.

But before the *Crepusculum* come to be shortest, there is another *Parallel*, in which the *Crepusculum* is equal to that of the *Equinoctial*: the *Declination* of which is found thus.

As the Radius or S. 90° 00′,
To S. of the *Poles Elevation* or *Altitude*,
So is S. of 18° 00′,
To S. of the *Declination* of the *Parallel*, in which the *Sun* maketh the *Crepusculum* equal to that in the *Equinoctial*.

PROP. XXI.

To find the Quantity of the Angles, which the Circles of the 12 Houses make with the Meridian.

This is the *Analogy* or *Proportion.*
As the Radius or S. 90°,
To T. *of* 60°: *for the* 11th, 9th, 5th and 3d *House*, Or to the T. 30° *for the* 12th, 8th, 6th, and 2d *House*,
So is the Sc. of the *Pole*,
To the Tc. of any *House* with the *Meridian*.

PROP.

PROP. XXII. §. 2.

To find the Right Ascension of the Point in the Equinoctial: and also the Point in the Ecliptick, called Medium Cœli or *Cor Cœli.*

First, To find the *Right Ascension* of the Point of the *Equinoctial*; called *Medium Cœli, vel Cor Cœli*, find out the *Sun's Right Ascension*, by prop. 2 Then reduce the whole Time from Noon last past into *degrees*, which add unto the *right Ascension* of the *Sun*, so shall their *Agragat*, be the *right Ascension* of the point, which in the *Equinoctial*, is called *Medium Cœli, vel Cor Cœli*, required to be found.

Secondly, By the 2 propositions aforegoing, you may find the *right Ascension* of the point in the *Ecliptick Culminant* in the *Meridian*, called *Medium Cœli* vel *Cor Cœli*, which is the *Cuspis of the tenth House*: and his *Declination* by prop. the first.

PROP. XXIII.

To find the Angle of the Ecliptick with the Meridian.

The *Analogy* or *Proportion* is.
As the Radius or S. 90°,
To S. of the *Sun's Greatest Declination*,
So is Sc. of the *Sun's right Ascension*, from the next *Equinoctial point*,
To Sc. of the *V.* of the *Ecliptick*, with the *Meridian*.

§. 2.

PROP. XXIV.

To find the Angle of the Ecliptick with the Horizon.

The *Analogy* or *Proportion* is.
As Radius or S. 90°,
To Sc. of the *Altitude* of *Cor Cœli*,
So is S. of the *V. Ecliptick* with the *Meridian*,
To Sc. of the *V.* of the *Ecliptick* and *Horizon* sought.

PROP. XXV.

To find the Amplitude Ortive of the Ascendent, or Horoscopus.

This is the *Analogy* or *Proportion.*
As Radius or S. 90°,
To S. of *Altitude* of *Med. Cœli*,
So is T. of *V. Ecliptick* with the *Meridian*,
To Tc. of the *Amplitude Ortive of the Ascendent, or the distance of the* Azimuth *from the Meridian.*

PROP. XXVI.

To find the Ascendent degree of the Ecliptick, or the Cuspis of the first House.

The *Amplitude Ortive* of the *Ascendent*, is equal to the Distance of the *Azimuth* of 90°, from the *Meridian*, wherefore the *Cuspis* of the first

first *House*, or *Ascendent Degree* of the *Ecliptick*, §. 2.
may be found thus.

As Radius or S. 90°,
To Sc. of the *V. Ecliptick* with the *Meridian*,
So is Tc. of the *Altitude* of *Med. Cœli*,
To T. of the Distance of *Med. Cœli*, from the *Ascendent Degrees*.

PROP. XXVII.

To find the Distance of the Cuspis of any House, from Med. Cœli.

This is the *Analogy* or *Proportion*.

As Sc. of the remaining part of *V*. of the *Ecliptick* with the *Meridian*, (found by prop. 28.)
To Sc of the former part of the *V*,
So is T. of the *Altitude* of *Med. Cœli*,
To T. of the Distance of the *Cuspis* of that *House* sought, from *Med. Cœli*.

PROP. XXVIII.

To find the parts of the Angle of the Ecliptick with the Meridian, cut with an Arch perpendicular to the Circle of any of the Houses.

The *Analogy* or *Proportion* is:

As Radius or S. 90°,
To Sc. *Altitude* of *Med. Cœli*,
So is T. of the Circle of any House with the *Meridian*,
To Tc. of that part of that Angle which is next the *Meridian*:

Then substract that part found, out of the whole Angle, for the remaining or latter part.

§. 2.

PROP. XXIX.

To find the Pole's Altitude, above any of the Circles of the Houses.

The *Analogy* or *Proportion* is.
As the Radius or S. 90°,
To S. of *V.* of the Circle of the House with the *Meridian* : (found by the 21 prop.) .
So is the S. of the *Poles Elevation,* above the *Horizon* of the Place,
To S. of the *Altitude* of the *Pole,* above the *Circle of Position.*

PROP. XXX.

By knowing the Latitude and Longitude of any fixed Star, to find his Right Ascension and Declination.

The *Analogy* or *Proportion* is.
1. *As Radius* or S. 90°,
To S. of the Stars *Longitude* from the next *Equinoctial point,*
So is Tc. of the *Stars Latitude,*
To T. of a *fourth Arch.*

Which compared with the *Arch of Distance* betwixt the *Poles of the World* and the *Ecliptick* 23°, 30′ ; And if the *Latitude* and *Longitude* of the *Star* be both of one Dignity, *i. e.* when the Star hath *North Latitude* in the six *Northern Sines,* ♈,♉,♊,♋,♌,♍, or *South Latitude* in the six *Southern Sines,* ♎,♏,♐,♑,♒,♓: Then shall the difference between this *found Arch,* and the Di-

Distance of the *Poles* be your *fifth Arch*: But §. 2.
if the *Latitude* and *Longitude* of the *Star* be of contrary qualities, *i. e.* the one *Northern*, and the other *Southern*, then add this *fourth Arch* to the Distance of the *Poles* 23° 30′, and the Sum thereof shall be your *fifth Arch*; with which,

AGAIN, say.

2. *As* S. of the *fourth Arch*,
To S. of the *fifth Arch*,
So is T. of the *Stars Longitude*,
To T. of the *Stars Right-ascension* from the next *Equinoctial point*.

3. *As* Sc. of the *fourth Arch*,
To Sc. of the *fifth Arch*,
So is S. of the *Stars Latitude*,
To S. of the *Stars Declination*.

☞ I might also shew how by having the *Latitude* and *Longitude* of any two *fixed Stars*, to find their Distance: but because 'tis the very same with finding the Distance of any two Places on Earth, I refer you to the Directions of *Prop.* 1, 2 *and* 3. of *Chap.* 7, ensuing, where you will see the plain Demonstration thereof.

PROP. XXXI.

By knowing the Pole's Altitude, to find when any fixed Star shall be due East or West.

This is the *Analogy* or *Proportion*.
As Radius or S. 90°,

§. 2. *To* T. of the *Stars Declination,*
So is Tc. of the *Pole,*
To Sc. of the *Stars Horary Distance* from the *Meridian.*

PROP. XXXII.

By knowing the Poles Altitude, to find the Elevation of any fixed Star above the Horizon, being due East or West.

This is the *Analogy* or *Proportion.*
As S. of the *Poles Altitude,*
To Radius or S. 90°,
So is S. of the *Stars Declination,*
To S. of the *Stars Elevation,* above the *Horizon,* at due *East* or *West.*

PROP. XXXIII.

To find out the Horizontal Parallax of the Moon.

The *Analogy* or *Proportion.*
As the Moons Distance from the *Center* of the *Earth,*
To the Earth's Semidiameter,
So is Radius or S. 90°,
So S. of the *Moon's Horizontal Parallax* in that Distance.

PROP.

§. 2.

PROP. XXXIV.

The Horizontal Parallax of the Moon being known, to find her Parallax in any apparent Latitude.

This is the *Analogy* or *Proportion.*
As Radius or S. 90°,
To S. of the *Moon's Altitude,*
So is S. of the *Moon's Horizontal Parallax,*
To S. of the *Parallax* in that *Altitude.*

PROP. XXXV.

By knowing the Moon's Place in the Ecliptick, (having little or no Latitude) and her Parallax of Altitude, to find the Parallaxes of her Longitude and Latitude.

First, If the *Moon* be in the 90° of the *Ecliptick*, she hath then no *Parallax* of *Longitude*, and the *Parallax* of the *Latitude*, is the very *Parallax* in that *Altitude.*

Secondly, But if the *Moon* be not in the 90th. Degree of the *Ecliptick*, to find the *Parallaxes* of the *Latitude* and *Longitude*, the *Analogy* or *Proportion* is,

1. *As Radius* or S. 90°,
To T. of the *V.* of the *Ecliptick* and *Horizon*,
So is Sc. of the *Moon's Distance* from the *Ascendent*, or *Descendent deg.* of the *Ecliptick*,
To Tc. of the *Ecliptick's V*, with the *Azimuth* of the *Moon.*

§. 2.

AGAIN say,

2. *As the Radius* or S. 90°,
To S. of that *V.* found,
So is the *Parallax* of the *Moon's Altitude,*
To the *Parallax* of her *Latitude* sought.

LASTLY say,

3. *As the Radius* or S. 90°, 00′
To Sc. *of the former V. found,*
So is the Parallax of the Moon's Altitude,
To the Parallax of his Longitude sought, which being added to the true Motion of the *Moon,* if she be on the *East* part of the 90° of the *Ecliptick.* Or from it to be deducted if she be on the *West* part of the 90° of the *Ecliptick.*

PROP. XXXVI.

How by knowing the Refraction of a Star, to find his true Altitude.

For the speedy performance of which I have annexed this Table of *Refractions* of the *Stars* observed by *Tycho Brahe* a Nobleman of *Denmark,* and a most famous *Astronomer.*

A Table

§. 2.

A Table of the Refraction of the Stars observed by *Tycho Brahe.*		
Altitude.	*Refraction.*	
0°	30′	00″
1	21	30
2	15	30
3	12	30
4	11	00
5	10	00
6	9	00
7	8	15
8	6	45
9	6	00
10	5	30
11	5	00
12	4	30
13	4	00
14	3	30
15	3	00
16	2	30
17	2	00
18	1	15
19	0	30
20	0	00

The USE of which Table is thus.

EXAMPLE.

Suppose the *Altitude* of a *Star* were found by Observation to be 13°; the correspondent *Refraction* is 4′ 00″, which substracted from 13° leaves 12°, 56′, which is the true Altitude.

CHAP.

CHAP. VII.

Of GEOGRAPHY.

Defin. G*EOGRAPHY is an art Mathematical, which ſheweth how the Situations of Kingdoms, Provinces, Cities, Towns, Villages, Forts, Caſtles, Mountains, Woods, Havens, Rivers, Creeks,* &c. *being on the Surface of the Terreſtrial Globe, may be deſcribed, and deſigned, in commenſuration Analogical to Nature, and Verity: and moſt aptly to our view may be repreſented.*

Ptolomy ſaith of *Geography*, Ἡ Γεωγραφία μίμησίς ἐστι διὰ γραφῆς, διαγραφῆς τοῦ κατειλημμένου τῆς γῆς μέρους ὅλου, καὶ τῶν ὡς ἐπίπαν αὐτῷ συνημμένων. *That it is a deſcription of all the known Earth, imitated by writing and delineation: with all other things belonging thereunto.* Of all which I ſhall ſay ſomewhat, as to its *Situation, Commodity, Cuſtoms,*&c. concerning which *Ovid* ſaith, *Met.*lib. 2.

Terra

than

Terra, viros, Urbesque gerit, frugesque, ferasque,
Fluminaque; hæc super est Cæli fulgentis imago.

In English Thus.

The Earth, Men, Towers, Fruits, Beasts, and Rivers bears,
And over these are place'd the Heavenly Spheres.

SECT. I.

Of GEOGRAPHICAL *Definitions.*

Defin. 1. THE Globe of the Earth is a Spherical Body composed of Earth, and Water, and is divided into *Continents*, *Islands* and *Seas*.

2. *A Continent* is a great Quantity of Land not separated, interlaced or divided by the *Sea*, wherein are *Kingdoms*, *Principalities* and *Nations*, as EUROPE, ASIA and AFRICA, are one *Continent*: and AMERICA is another.

3. *An Island* is such a part of the Earth that is environed round with Water on every Side, as the Isle of *Great Britain*, *Java*, *Wight*, &c.

4. *A Peninsula* is such a Tract of Land which being almost cut off from the Main Land, and encompassed round with Water, yet nevertheless is joyned unto the firm Land, by some little *Isthmus*, as *Peloponesus*, *Peruviana*, *Taurica*, *Cymtryca* and *Morea* in the *Levant*.

5. An

§. 1. 5. An *Iſthmus* is a little narrow Neck of Land which joyneth the *Peninſula* unto the *Continent*.

6. A *Promontory* is ſome high Mountain, which ſhooteth it ſelf into the Sea, the utmoſt end of which is called a *Cape*: as *Cape-boon*, *Eſperance*, *Cape d' Verde*, and *Cape d' Coquibocao*.

7. The *Ocean* is a general Collection of Waters, which environeth the World on every ſide, and produceth *Seas*, *Straits*, *Bays*, *Lakes*, and *Rivers*: Of which and other Waters *Ovid* thus ſpeaks in his *Metamorphoſis*.

Tum Freta diffudit, rapidiſque tumeſcere ventis
Juſſit, & ambitæ circundare littora terræ.
He ſpread the Seas, which then he did command
To ſwell with Winds, and compaſs round the Land.

8. The *Sea* is part of the *Ocean*, to which we cannot come but through ſome *Strait*, as the *Mediterranean*, or *Baltick Sea*.

9. A *Strait* is a part of the *Ocean* reſtrained within narrow bounds, yet openeth a way to the *Sea*, as the *Straits* of *Gibralter*, *Heleſpont*, &c

10. A *Creek* is a crooked Shoar thruſting, as it were, two Armes forth to hold the *Sea*; as the *Adriatick*, *Perſian*, and *Corinthian Creeks*: from whence are produced *Rivers*, *Brooks* and *Fountains*: which are engendred of *Congealed Air* in the *Earths Concavity*, and ſeconded by *Sea-water* creeping through the hidden *Cranies* of the *Earth*.

11. A *Bay* is a great Inlet of Land, as the *Bay* of *Mexico*, and *Biſcay*.

12. A *Gulph* is a greater Inlet of Land and deeper

deeper than a *Bay*, as the *Gulph of Venice*, and *Florida*. §. 1.

13. A *Climate* is a certain ſpace of Earth and Sea, included within the ſpace of two *Parallels*; and there have been anciently accounted theſe ſeven: *viz.* 1. *Dia Meros*, 2. *Dia Syenes*, 3. *Dia Alexandria*, 4. *Dia Rhodes*, 5. *Dia Rhomes*, 6. *Dia Boriſthenes*, and 7. *Dia Ripheos.*

14. A *Zone* is a certain ſpace of *Earth* contained betwixt certain *Circles* of the *Sphere*, of which there are five: *viz. The Torrid or Burning Zone, two Temperate, and two Frigid or Frozen Zones.*

The *Torrid Zone* is that which lieth on each ſide the *Equinoctial*, whoſe bounds are the two *Tropicks* of ♋ and ♑.

The two *Temperate Zones* are thoſe which lieth betwixt the two *Tropicks* of ♋ and ♑, and the *Palar Circles.*

The two *Frigid Zones* lieth between the *Artick* and *Antartick Circles*, and their reſpective *Poles*: Of which *Ovid* thus ſpeaks.

Metam. 1.

Utque duæ dextrâ Cœlum, totidemque ſiniſtrâ
Parte ſecant Zonæ, *quinta eſt ardientior illis:*
Sic onus incluſum munero diſtinxit eodem
Cura Dei, totidemque plaga tellure premuntur:
Quarum quæ media eſt, non eſt habitalis æſtu;
Nix tegit alta duas: totidem inter utramq; locavit
Temperiemque dedit miſtâ cum Frigore Flammâ.

SECT.

§. 2.

SECT. II.

Geographical Descriptions of the Earth.

THE whole Earth is divided into four parts.

VIZ.

EUROPE,	AFRICA and
ASIA,	AMERICA.

Europe. EUROPE, the first part of the World, is divided from ASIA by the *Mediterranean Sea*; bounded on the West with the *Western Ocean*; East with the River *Tanais*. It is lesser than ASIA, or AFRICA, yet doth excell all the other parts, in *Worthiness*, *Fame*, *Power*, multitudes of well builded *Cities*, strong *Fortifications*, full of a *Wity* and *Learned People*, Courageous *Wariours*, and the knowledge of *God*, better than all the Riches of the World. It once had the dominion of ASIA and AFRICA, and in it were fourteen Mother Tongues, and doth contain these Provinces: *Viz. Italy*, *Spain*, *Alps*, *France*, *Britain*, *Belgia*, *Germany*, *Denmark*, *Sweden*, *Russia*, *Poland*, *Hungary*, *Sclavonia*, *Dacia*, and *Greece*, with its several *Islands*, which shall be mentioned in their due places.

Italy

§. 2. Europe.

Italy * the Mother of *Latine* learning, is bounded East with the *Adriatick* and *Tuscan Seas*, West with *France*, North with *Germany*, and South with the River *Varus*, and the *Alps*. It hath had seven kinds of Governments: First *Kings, Dictators, Consuls, Decimivires, Tribunes, Emperours*, and lastly *Popes*. It far excelleth all the other Lands in *EUROPE* in fruitfulness and pleasantness. The Inhabitants are witty and frugal, yet hot and lascivious, and very jealous of their Wives; they are of the *Popish* Religion, and its chief Commodities are *Rice, Silk, Velvets, Sattins, Taffeties, Grogerams, Arras, Gold* and *Silver, Threed, Venetian Glasses*, &c.

* *Which* Pliny *hath adorned in these words (saith he) Italia terrarum omnium alumna, eadem & parens, numine Deûm electa, qua Cœlum ipsum clarius faceret, sparsa congregaret imperia, ritus molliret, tot populorum discordes linguas sermonis commercio ad Colloquia distraheret, & humanitati hominem daret*, i.e. Italy (*saith* Pliny) *is the Nurse and the Parent of all Religion, was elected by the Providence of the* Gods, *to make (if possible) the* Heavens *more famous; to gather the scattered* Empires *of the World into one Body, to temper the* Barbarous *rites of the Nations, to unite so many disagreeing* Languages *of Men by the benefit of one common Tongue: and in a word to restore Man to his Humanity.*

Italy at this day contains the Kingdom of *Naples, Sicily, Sardina*, the Lands of the *Pope*, now *Innocent the XI.* the Dukedom of *Tuscany, Urbin, the Republick of Venice, Genoa, and Luca.* The Estates of *Lumbardy*, being the Dukedom of *Millain, Mantua, Modena, Parma, Mountferrat*, and the *Principality of Piemont*, of all which we shall treat in their order.

The

Europe. §. 2. The Kingdom of *Naples* is environed with the *Adriatick*, *Ionian*, and *Tuscan Seas*; except where it is joyned to the Lands of the *Church*, from which 'tis separated by a line drawn from the mouth of the River *Tronto*, falling into the *Adriatick*, and to the spring-head of *Axofenus*, taking in all the East of *Italy*, 1468 miles. It is very fertile, abounding with all things necessary for the life of Man, delight, and *Physick*: from hence come the *Neopolitan* Horses. It hath had 13 *Princes*, 24 *Dukes*, 25 *Marquesses*, 19 *Earls*, and 900 *Baronets*, and 26 *Kings* of several Countries of the *Norman* and *Spanish* race, whom 'tis now under: here the Disease called the *French-Pox* derived its *Original*: the Arms are *Azure Seme* of *Flower-d'-lices*, or a File of three *Lables Gules*; its revenues are 2500000 *Crowns*, 20000 of which belongs to the *Pope*, and the rest are imployed to maintain the *Garisons* against the *Turks*; so that scarcely 60000 *Crowns* falls to the King of *Spain*s share; it hath 20 *Archbishops*, and 124 *Bishops* Sees.

Sicily is situated under the fourth *Climate*, it shoots forth into the Seas with three *Promontories*; the Inhabitants are Eloquent, Ingenious, and Pleasant, but very unconstant, and Talkative; the first Inventors of *Oratory*. It's a fruitfull Soil, it yields *Wine*, *Grain*, *Oyl*, *Hony*, *Gold*, *and Silver*, *Agats*, *Emeralds*, *Allom*, *Salt*, *Sugar*, *and Silks*. Here is the Hill *Ætna*, supposed to be Hell, and by the *Papist Purgatory*, because of its vomiting Smoak and Fire: it hath many *Cities*, *Rivers*, *Lakes*, whose descriptions must here be omitted; it hath had eight Kings; the first were of the *Arragon* Family, and began to

Rule *Anno* 1281. But it's now united to the Crown of *Spain*; its Revenues are 800000, or a 1000000 of *Ducats*, which is disburst on the Account of the *Vice-Roy*, and Defence of the Countrey; the Arms are four *Pallets Gules*; Sable for *Aragon*, between two *Flanches Argent*, charged with as many Eagles *Sable beaked Gules*. It hath had seven *Princes*, four *Dukes*, thirteen *Marquesses*, fourteen *Earls*, one *Viscount* and forty-eight *Barons*, they are of the *Romish* Religion, and have three *Archbishops*, and nine *Bishops*. §. 2. *Europe.*

The Kingdom and Isle of *Sardina*, lieth West from *Sicily* and *Cap Bara*, whose length is 180; and breadth 90 Miles; the People are low of Stature, and of a swarthy Complection, rude, slothfull, and rebellious, their diet mean, yet rich in their Apparel, they are of the *Romish* Religion; but have an ignorant and illiterate *Clergy*. It belongs to the King of *Spain*, and governed by a *Vice-Roy*, under whom are two *Deputy Spaniards*: but other inferiour Officers may be Natives. It hath neither *Wolf*, nor *Serpent*, nor venemous Beast, but the *Fox* only, and a little *Spider*, which cannot endure the light of the *Sun*; they are destitute of Water, and are therefore forced to keep the Rain that falls in *Summer* for their Use in *Winter*, the Air is unhealthfull and *Pestilential*; the Soyl Fertile, but ill manured; it hath plenty of *Cattel*, their *Horses* will last very long, the Natives ride on their *Bullocks* as we on our Horses, here is also a Beast called *Mufrones*, resembling a Stagg, whose Hide is used as Armour, and an Herb which eaten produces Death with excessive laughter, it yields to the King of *Spain* but a

§. 2. ſmall Revenue. The Arms are *Or*, a Croſs *Gules* betwixt four *Sarazens Heads*, Sabled Curled

Europe. *Argent*, it hath ſeveral *Iſles* belonging thereunto, it hath three *Archbiſhops*, and fifteen *Biſhops*.

The Lands of the *Church* or the *Pope's Dominion* in *Italy*, lieth Weſt of *Naples*, extended North and South from the *Adriatick to the Tuſcan Seas*, bounded on the North with the River *Trontus*; on the South-eaſt with *Axofenes*: hy the Rivers *Poe* and *Frore*, ſeparated from the *Republique* of *Venice*, on the South-weſt by the River *Piſcio*; by which 'tis divided by the Modern *Tuſcany*, it is in the middle of *Italy*, its breadth is 115, and length 300 Miles, it's moſt exceeding fruitfull, very Populous, there have been 15 *Exarches* of *Ravena* in *Romandiola*, 17 *Dukes* and *Marqueſſes* of *Ferata*; the Revenue thereof to the Pope is 250000 Crowns, there hath alſo been 6 *Dukes* of *Urbin*, its Revenue are 100000 Crowns, but the moſt ſplendid Glory of *Italy* is the City of *Rome*, ſometimes the Empreſs of the World, and was the Seat of the paſt Popes, and the now preſent *Pope Innocent the XI.* the inferior ſpiritual Governours, are theſe, *Viz. Cardinals*, *Friers* of the Order of St. *Baſil*, *Auſtin*, *Jerome*, *Carmelites*, *Crouchedfriers*, *Dominicans*, *Benedictines*, *Franciſcans*, *Jeſuits and Oratorians*; and of *Nuns*, the Order of St. *Clear* and *Bridget*, which to name wholly doth deſerve a particular Treatiſe, here are 44 *Archbiſhops*, and 57 *Biſhops*.

The Republique of Venice, lieth Northward of the *Popes Dominions*, from *Romandiola* to the *Alps*, limited on the South with the Territories of

of *Ferrata*, and *Romandiola* ; on the West with the *Dukedom of Millain*; on the North with the *Alps*; and on the East with the *Adriatick Sea*, and the River *Arsia*. It is a very fruitfull Countrey, well peopled, their Government *Aristocratical*, and popular, their Religion *Popish*, they baptize the Sea yearly ; they have had a hundred *Dukes*, they have two Principal Orders of Knighthood of St. *Mark* the Patron of the famous City of which the Poet speaks. §. 2. *Europe.*

Viderat Adriacis venetiam Neptunus inundis
Stare Urbem, & toto ponere jura mari :
Nunc mihi Tarpeias, quantumvis Jupiter, arces
Objice, & illa tui mœnia martis ait.
Sic Pelago Tibrim præfers, urbem aspice utramq;
Illam homines dices, hanc posuisse Deos.

Instituted 1330, and renewed 1562, they are to be all of Noble Blood: their Motto is *Pax tibi Marce*. The other is of the Glorious *Virgin*, instituted 1222, their Duty is to be a refuge to *Widows* and *Orphans*, and to procure the peace of *Italy* ; their Habit a *White Surcoat* over a *Russet Cloak*, representing *Religion*, as well as *Belliarcity*, there are two *Patriarchs*, and sixteen *Bishops*.

The Dukedom of *Florence*, being the Seat of the Great Duke of *Tuscany*, is bounded on the East by the River *Pisca* ; on the West by the River *Macra*, and the Fort *Sarzana* ; on the North by the *Appenuine* Hills ; and on the South with the *Tuscan Seas*. Its length is 261 Miles, and breadth not known ; the Order of Knighthood is that of St. *Stephen*, instituted 1567, they

§. 2. are to be Nobly born, and in lawfull Wedlock, without Infamy: their Robe is of White *Chamblet*, with a *Red-Cross* on the left Side of their Midway Garment, their Number I cannot certainly know, the *Grand Duke* is their *Sovereign*; the Revenue of this Countrey is great, their *Duke* is also a Merchant, and receiveth *Excise* of all *Commodities*, the Arms is *Or*, five *Tortecax Gules*, two, two, and one, one, on chief *Azure* charged with three *Flower-de-Luces*, of the first. They are of the *Popish* Religion, and they have three *Archbishops*, and twenty six *Bishops*.

Europe.

The Estate of *Luca*, lieth betwixt the Estate of the *Grand Duke, and the Republique of Genoa*: The Government is *Aristocratical, and Democracy*, their Principal Magistrate is called, *Gon Fatinere*, and is changed every second Month: being assisted by a certain Number of Citizens, which are changed every six Months, during which time they lie together in the *Common Hall*; their *Protector* is Elective from some Neighbouring Prince: they are a very generous People, good Merchants, they sell rich Cloths of *Gold* and *Silver*; the Revenues yearly are 80000 *Crowns*, it can raise for War 15000 *Foot*, and 3000 *Horse*, they are of the *Popish* Religion, and have two *Bishops*, and acknowledge the *Bishop* of *Florence* for their *Metropolitan*.

The Republique of *Genoa*, lieth West of *Tuscany*, from whence 'tis divided by the River *Macra*, it was formerly a large State but have now only *Liguria*, and the Isle of *Corsica*; the Inhabitants are good Warriours, Merchants, and subtle *Userers*; here the Women have the most liberty

liberty of any in all *Italy*, so that they may converse with whom they will, either publiquely, or privately; from hence ariseth a Proverb, *That Genoa is a Country of Mountains without Woods; Seas without Fish; Men without Faith; and Women without shame.* They have a *Duke*, with Eight *Assistants*, all subject to the General Council of 400 Men; which hold but two years, they are of the *Popish* Religion, and have one *Archbishop*, and fourteen *Bishops*. §. 2. *Europe.*

The Estates of *Lumbardy* is bounded on the East with *Romandiola*, and *Ferrata*; on the West and North with the *Alps*; and on the South with the *Apenuine* hills: Now as *Italy* is the Garden of EUROPE, so is *Lumbardy* of *Italy*, for its exceeding Fruitfulness.

The Dukedom of *Millain* hath on the East the State of *Mantua*, and *Parma*; on the West *Piemont*, and part of *Switzerland*; on the North *Marca Trevigana*; and on the South the *Apenuine*, parting it from *Liguria*: it was once the chief Dukedom in Christendom, and is now in the *Spanish Territories*; its Revenues are 8000 *Ducats*, their Arms are *Argent*, a *Serpent Azure* Crown'd, *Or*, in his *George* an *Infant Gules*, their Religion is *Popish*, they have one *Archbishop*, and six *Bishops*.

The Dukedom of *Mantua*, is bounded West with *Millain*; East with *Romandiola*; North with *Marca Triugiana*; and South with the Dukedom of *Parma*. The Countrey yields good store of *Corn*, *Fruit* and *Wine*, the Inhabitants are rustick, foolish in their Apparel, it is a free state and hath had many Dukes, the Order of Knighthood is that of the *Blood* of *Christ*: in-

§. 2. ſtituted 1608, it conſiſteth of twenty Knights, the *Mantuan Duke* is their *Sovereign*; the Coller hath threads of Gold, layed on with Fire, with this Motto *Domine probaſti*, to the Collar are pendent two *Angels*, ſupporting three drops of *Blood*, and circumſcribed with this Motto, *Nihil iſta triſte receptô.* Its Revenue is 500000 Ducats; Its Arms are *Argent*, a Croſs *Patere Gules*, between four Eagles, *Sable* membred of the ſecond, under an *Eſchucheon* in *Fiſe*, charged quarterly with *Gules*, *a Lion Or*, and *Or*, three barrs Sable: Their Religion is *Popiſh*, here is one *Archbiſhop*, with four *Biſhops*.

Europe.

I ſhall paſs by the Dukedoms of *Modena*, *Parma* and *Mountferrat*, they being but ſmall Eſtates of *Italy*, having but four *Biſhops*: they are of the *Popiſh Religion*, the Arms of *Modena* and *Parma* are as *Ferrata*; and the Arms of *Mountferrat*, a chief *Argent*.

And here we ſhould deſcribe *Piemont* the laſt part of *Italy*, but being but part in *Italy*, and the *Alps* belonging to the Duke of *Savoy*, I ſhall defer it to the *Alpian* Deſcriptions.

Now *Italy* hath theſe moſt famous Cities, *viz. Genoa*, *Milain*, *Venice*, *Florence*, *Rome*, *Bologne* and *Naples*, the Rivers moſt famous are *Arnus*, *Po* and *Tiber*, and ſo much for *Italy*.

The *Alps* begin about the *Liguſtick Seas*, and croſſeth all along the Borders of *France* and *Germany*, and extend as far as the *Gulph* of *Cornero*; It hath theſe Provinces, *viz.* the Dukedom of *Savoy* (to which *Piemont* belongs) *Geneva*, *Walliſland*, *Switzerland*, and the Countrey of the *Grizons*, of all which I ſhall give a ſhort and plain Deſcription.

Piemont

§. 2.] Europe.

Piemont is part of the *Alps*, situated at the Foot of the Mountains, bounded North with the *Switzes*; East with *Millain and Mountferrat*; West with *Savoy*; and on the South it runneth into a Narrow Vally to the *Mediterranean*, having *Mountferrat* on one side, and *Province* and part of the *Alps* on the other · it's very fruitfull compar'd with *Savoy*, but yet inferiour to any part of *Italy*: The Arms are *Gules*, a Cross *Argent*, charged with a *Lebel* of three points *Azure*.

Savoy is bounded East with *Wallisland* and *Piemont*; West and South with *Daulphin*, and *La-Bress*; and North with *Switzerland*, and the Lake of *Geneva*: this is a Mountainous Countrey, very healthfull, but not very fruitfull. The Inhabitants are dull and slothfull, it hath had thirty *Dukes* and *Earls*, it is a place of Natural strength; its Revenues is yearly 1000000 of *Crowns*. The order of Knighthood is that of *Anunciado*, instituted 1480, their Coller hath 50 links, (to shew the Mystery of the Virgin) appendent to it is her Effigies, and instead of a Motto these Letters F. E. R. T. i. e. *Fortitudo ejus Rhodum tenuit*, which is engraven on each link of the Chain, interwoven like a True lovers-knot. The Number fourteen, besides the *Duke Soveraign* of the Order, their Arms are *G.* a Cross *A.*

Geneva was a City of the Dukedom of *Savoy*, but now a free State: having both cast off the Duke and his Holiness the *Pope*, with all the *Clergy*. They are now *Calvanist Protestants*: their Government *Presbyterial*; their Language the worst of *French*, they are an industrious People, and good Merchants.

§. 2. *Wallisland* reacheth from the Mount *De Burken*, to the Town of St. *Maurice*, where
Europe. the Hills do shut up the Valleys,so that a Bridge is lain from one Hill to 'tother, under which passeth the River *Rosue*, which Bridge is defended by a Castle and two strong Gates; on the other side 'tis surrounded with steep and horrid Mountains; covered with a Crust of *Ice* not passable by Armies; the Inhabitants are courteous to Strangers, but unnatural to each other: they are of the *Romish* Religion, and subject to the Bishop of *Sion*; the Deputies of the seven *Resorts*,have voices in his Election,and joyn with him in *Diets*, for chusing Magistrates; desiding Grievancies, and determining matters of State. The Valleys of this Countrey is very fruitfull in *Saffron*, *Corn*, *Wine* and *Delicate Fruits*, they have a Fountain of *Salt*, many hot *Baths*, and *Spaw-Waters*, they have plenty of *Cattle*, with a wild *Stag* footed as a *Goat*,and horned as a fallow *Deer*: who in Summer is blind with heat.

Switzerland is bounded East with the *Grisons*; West with *Mount-Jove* and the Lake of *Geneva*; North with *Suevia*; and South with *Wallisland*, and part of the *Alps*; this Land is a very Mountainous Countrey, but yet hath some rich Meddows. It is 240 in length and 180 Miles in breadth, the Inhabitants are rich, but rugged like their Soyl: good Souldiers: they are some *Papists* and some *Protestants*, others *Zwinglians*, yet have they toleration under a *Popular* Government.

The Countrey of the *Grisons* is bounded East with *Tyrol*, North with *Switzerland*, South with

with *Suevia*, *Switzerland*, and *Lumbardy*; it is a very Mountainous and Barren Land, their Religion *Protestant*, their Government *Popular*; there are in this *Alpin* Provinces two *Archbishops*, and thirteen *Bishops*. Its chief Cities are *Turin*, *Geneva*, *Basil* and *Zurich*, in all of which are Universities. §. 2. Europe.

France is bounded East with *Germany*; and South and East with the *Mediterranean Seas* and *Alps*; North with the *British Seas*; It hath been esteemed the worthiest Kingdom in Christendom, it yields plenty of *Grains* and *Wines*, wherewith it supporteth other Lands, it consisteth of many great *Dukedoms* and *Provinces*. It hath great and mighty Cities, the People are Ingenious and good Warriers, the Government is *Monarchial*, their Religion *Popish*, but intermixt with *Protestants*, which of late hath endured grievous Persecutions. Their Orders of Knighthood are that of St. *Michael* instituted 1409, consisting of 300 Persons, their Habit is a long Cloak of *White Damask* down to the Ground, with a Border interwoven with *Cockleshels* of Gold, interlaced and furred with *Ermins*, with a Hood of *Crimson-velvet*, and a long *Tippit* about their Necks, and a Coller woven with *Cockleshells*, with this Motto, *Immensi tremor Oceani*, to it hangs appendent the Effigies of St. *Michael* conquering the *Dragon*. Their Seat is St. *Michael's Mount* in *Normandy*. 2dly the Order of the Holy Ghost instituted 1579, so that whosoever was admitted to the Order of St. *Michael*, must and was first dignified with this; proving their Nobility by three Descents; and be bound by Oath to maintain the

§. 2. the *Romish* Religion; and persecute all Dissenters thereunto. Their Robe is a *Black Velvet Mantle*, portrayed with *Lillies* and *Flames* of *Gold*: the *Coller* of *Flower-de-Luces*, and Flowers of *Gold*, with a *Dove* and *Cross appendent* to it. The Arms of *France*, are *Azure* three *Flower-de-Luces*, *Or*; It hath seventeen *Archbishops*, 107 *Bishops*, 132000 *Parishes*, and hath these Magnificent Cities, *viz. Amiens*, *Rouen*, *Paris*, *Troys*, *Nants*, *Orleans*, *Diion*, *Lyons*, *Burdeaux*, *Toulose*, *Marsailles*, *Grenoble* and *Anverse*; the Rivers of most Note are the *Loyre*, *Garom*, *Rhone* and the *Seyne*.

Europe.

The *Pirenean-hills* lyeth betwixt *France* and *Spain*, and are two Potent Kingdoms, esteemed 240 Miles long, the People are barbarous and scarce of no Religion at all.

Spain is separated from *France* by the *Pirenean-hills*; on all other sides environed with the *Sea*; this Land yieldeth all sorts of *Wine*, *Oyl*, *Sugars*, *Grains*, *Metals*, as *Gold* and *Silver*, and it is Fertile; the Inhabitants are *Ambitious*, *Proud*, *Superstitious*, *Hypocrites* and *Lascivious*, yet good Souldiers; by enduring *Hunger*, *Thirst*, *Labour*, &c. It containeth divers Kingdoms. 1. *Goths*. 2. *Navars*, it hath had 41 *Kings*. Their Arms are *Gules*, a Carbuncle *Nowed Or*, their Order of Knighthood was of the *Lilly*, their Blazon a Pot of *Lillys*, with the *Effigies* of the *Virgin* on it, their Duty is to defend the Faith, and daily to repeat a certain Number of *Ave-Maries*. 3dly *Biscay* and *Empascon*, hath had nineteen *Lords*, their Arms *Argent*, two *Wolves Sable*, each in his Mouth a *Lamb* of the second. 4ly *Leon* and *Oviedo* hath had thirty

Kings,

Kings, the Arms *Argent*, a *Lion Passant* crowned *Or*. 5ly. *Galicia* hath had ten *Kings*, the Arms *Azure Sema* of Cressels fiched a *Chalice* crowned *Or*. 6ly. *Corduva* hath had twenty *Kings*, the Arms *Or*, a *Lion Gules* armed and crowned of the first, a Border *Azure* charged with eight *Towers Argent*. 7ly. *Granado* hath had twenty *Kings*, the Arms *Or*, a *Pomgranet* slipped *Vert*. 8ly. *Marcia*. 9ly. *Tolledo* hath had eleven Morish *Kings*. 10ly. *Castile* hath had twenty *Kings*, the Order of *Mercia* is his chief Order, here the Armes is a Cross *Argent*, and four *Beads*, *Gules* in a Field *Or*, their Habit white, the Rule of their Order that of St. *Augustine*, they are to redeem Captives from *Turky*. 11ly. *Portugal* (the Native soyl of the most serene *Catharine Queen Dowager*) hath had 21 *Kings*, the Orders of Knight here is first *Avis*, wearing a Green Cross, 2dly of *Christ* instituted 1321, their Robe is a black Cassock under a white *Surcoat* with a Red Cross hanging in the midst a white Line, and their Duty is to expell Mores out of *Boetica*, the Arms are *Argent*, on five *Escucheons Azure*, as many *Besants* in saltire of the first pointed, Sable within a powder *Gules*, charged with seven *Towers Or*. 12ly. *Majorica* hath had four *Kings*. 13ly. *Arragon* hath had twenty *Kings*, their Order of Knighthood is of *Mintesa*, their Robe a red Cross on their Breast, the Arms *Or*, four *Pallets Gules*, all which Kingdoms are now united into one *Monarchy*, under the *King* of *Spain*, their Religion *Popish*: the King is not rich by reason of his great Expences to keep his Dominions, in which are eleven *Archbishops*, and

§. 2.

Europe.

§. 2. and 52 *Bishops*, and hath these most notable Cities, *viz. Toledo, Madrid, Leon, Fax, Sivil-*
Europe. *le, Grenado, Mursy, Saragosa, Bracelon, Pam-phelune, Bilbo, Priede*, St. *James* of *Compostella*, and *Lesbone*, and Rivers famous are the *Dower*, *Tagus, Gadian* and *Guadalguinr*.

Great Britain consisteth of *England* and *Scotland*, and is the Biggest Isle in *EUROPE*, and the *Glory* thereof; it is a temperate Soyl, a sound Air, and yieldeth all manner of good things, 'tis environed all round with the Seas; I shall begin first with *England*.

England hath many pleasant Rivers well stored with *Fish*, excellent *Havens*, commodious *Mines* of *Silver, Lead, Iron* and *Tinn*, abundance of *Woods*, good *Timber*, plentifull in *Cattle*, good *Wool* of which is made fine Cloath, which serves not only themselves but vended into other Countreys, the chief City is *London*, in which are two of the Wonders of the World, *viz.* the *Monument* and *Bridge* over the *Thames*, the People are brave Warriers, both by Sea and Land, as *Europe* has felt and can testifie to their Grief, they are learned in all manner of noble Sciences; the Order of Knigthood is that of St. *George*, or the *Garter*, there are 26 Knights of it, whereof the *King* is the *Soveraign*, their Ensign is a blue Garter buckled on the left Leg, with this Motto—*Hony Soit Qui Mall Y Pense*, and about their Necks they do wear a blue Ribbon, at the End of which hangs the Image of St. *George*, upon which day this Order is Celebrated: secondly of the *Bath*, instituted 1009, they use to be Created at the *Coronation* of *Kings* and *Queens*, and at the *Enstalling* of

of the *Prince* of *Wales*. The Knights thereof distinguished by a red Ribbon, which they wear about their Necks, their Duty is to defend *Religion*, *Widows*, *Maids* and *Orphans*, with the *Kings right*. Thirdly of *Barronets* and *Hereditary Honour*, the Arms are *Mars*, three *Lions Passant*, *Gardant Sol*, their Religion is the *Protestant*; they have two *Archbishops* and twenty *Bishops*. The length of *England* is 320, and breadth 250 Miles, it hath 857 famous *Bridges*, 325 Rivers, it's defended and invironed with Turbulent *Seas*; guarded by unaccessible *Cleves* and *Rocks*; and defended by a strong and Puissant *Navy*; so that of it may well be said, §. 2. Europe.

Insula prædives, que toto vix eget Orbe;
Et cujus totus indiget Orbis ope.
Insula prædives, cujus miretur & optet
Delicias Solomon *octavianus opes.*

Its chief Cities are *London*, *York*, *Bristol*, and Rivers are the *Thames*, *Severn*, *Humber*, and the *Ouze*.

Wales is bounded on all sides with the Sea, except towards *England* on the East; it is a barren and mountainous Countrey: Its chief Commodities are their *Freeze*, and *Cottons*. The Inhabitants are faithfull in their promises to all men, but yet much enclined to Choler, and subject to Passion, which *Aristotle* calleth ἀκρoχολία. It contains 14 *Shires*, 13 *Forests*, 36 *Parks*, 230 *Rivers*, and 1016 *Parishes*. They are so resolute and valiant (saith *Henry* III. writing to *Emanuel* then *Emperour* of *Constantinople*) "*That they dare encounter Naked with*

" *armed*

§. 2. "*armed Men, being ready to spend their Blood for* "*their Countrey, and pawn their Life for Praise.*

Europe. They are *Protestants*, and have four *Bishops*; but no Towns of Note.

Scotland is the Northern part of *Britain*, environed all round with the *Sea*, unless where it is joyned to *England*. *Polydore* saith it is 480 in length, and 60 miles in breadth, divided into *Highlands* and *Lowlands*: the *Highlands* are *Irish-Scots*, and the *Lowlands English-Scots*. It is not so fruitfull as *England*; the chief City is *Edenbrough*. Its Commodities is course *Wool*, and *Cloth*, *Malt*, *Hides*, and *Fish*. The Order of Knighthood is that of St. *Andrew*, the Knights did wear about their Necks a Coller interlaced with *Thistles*, with the Picture of St. *Andrew* appendant thereunto, having this Motto—— *Nemo me impune lacessit*. 2. Of *Nova Scotia* instituted by King *James*, *Anno* 1622, hereditary the Knight hereof distinguished by a Ribbond of *Orange-tawny*. The Arms of *Scotland* is *Sol*, a *Lion Rampant*, *Mars* within a double *Tressure* counterflowered; they are *Protestants*, and have 2 *Archbishops* and 12 *Bishops*. The Cities most Famous are *Edenbrough*, *Sterlin*, *Aberdeen* and St. *Andrews*: and they have the Famous Rivers *Tay* and *Tweed*.

Ireland is on all sides environed round with the *Irish Seas*, and St. *Georges Channel*. Its length is 300 and breadth 120 miles. The Natives are *strong* and *nimble*, *haughty*, *careless*, *hardy*, *bearing cold and hunger with patience*: and in a word, if they are bad you shall never find worse; but if good scarcely find better. The *Wild Irish* have a custom to kneel down to the

the *New Moon*, praying it to leave them in as good health as it found them. They received the Christian Faith 435. The Soil is fruitfull and it hath good *Pasture*, yet full of *Boggs* and *Woods*, and multitude of *Fowls*, and in it will dwell no venomous Creature. The Revenues yearly have been 40000 *li.* The Air is Temperate, cooler in *Summer*, and hotter in the *Winter* than in *England.* Their Arms are *Azure* an *Harp* or *stringed Argent*, they are some *Protestants* and *Papists* mixt: they have 4 *Archbishops*, and 19 *Bishops*; the chief City is *Dublin.*

The *Islands* belonging to *Great Britain*, are 1. *Wight* (the place where I first drew my Breath, and the Land of my Nativity) 2. *Surlings*, 3. *Garnsey*, 4. *Jersey*, 5. *Anglesey*, 6. *Man*, 7. *Hebrides*, 8. *Orcades*, 9. *Portland*, 10. *Sunderland*, 11. *Holy Island*. And thus I have done with the *British Empire*; all these Parts described belong to it, and are under the Royal Sceptre of his Sacred Majesty *JAMES* the Second (whom God long preserve.) Thus I have finished the description of *Great Britain* having this only to say—— *Quæ Deus conjunxit nemo separet.*

Belgia, or the *Low Countreys*, consisteth of several wealthy Provinces: *viz.* The Dukedom of *Brabant*, *Guelderland*, *Lymburge*, *Flanders*, *Artois*, *Henault*, *Holland*, *Zeland*, *Mamen*, *Zukfen*, the *Marquisate* of the *Holy Empire*, *Freezeland*, *Michleu*, *Ouserisen*, and *Graving*. All which Lands are very fertile and populous, having 208 *Cities*, and 6300 *Villages*, with *Parish-Churches*, *Castles*, and *Forts*; and is watered with

§. 2. with the *Rhine* and the *Mose*, the *Mara* and the *Sheld*. It hath commodious *Havens*, the Europe. Inhabitants are brave *Warriours*, good *Mechanicks*, their chief Commodity is *Rhenish Wine*, *Linnen* and *Woollen Cloth*, *Camericks*, *Lace* of *Gold* and *Silver*, *Silk*, *Taffatys*, *Velvet*, *Grogerams* and *Sayes*, all manner of *Twined threds*, *refined Sugars*, *Buff*, *Ox-hides*, *Spanish-leather*, *Pictures*, *Books*, *Cables*, *Ropes* and *Herrings*. Now *Belgia* is bounded East with *Westphalen*, *Gulick*, *Cleve*, and the Isle of *Triers*; West with the Main *Ocean*; North with the River *Ems*; and South with *Picardy* and *Champagne*. The People are of the reformed Religion all except *Flaunders* and *Artoise*, and they have the *Popish Tenents*, here are three *Archbishops*, and fifteen *Bishops*. The Order of Knighthood is that of the *Golden Fleece*, instituted 1439 their Habit is a Coller of Gold, interlaced with *Iron*, *Or. Ex ferre Flammam*, at the end thereof hangs a *Golden Fleece*. Their chief Cities are *Mentz*, *Antwerp*, *Amsterdam*, *Roterdam*, and Rivers are the *Sheild* and *Mosa*.

Germany is the greatest Province in all EUROPE, and is bounded East with *Russia*, *Poland* and *Hungary*; West with *France*, *Switzerland* and *Belgia*; North with the *Baltick Seas*, and part of *Denmark*; and South with the *Alps* and parted from *Italy*: it contains *Bohemia* and *Pragu*, it is adorned with Magnificent *Towers*, strong *Fortifications*, *Castles* and *Villages*, very Popular; the Soyl is Fertile; many Navigable Rivers do to it belong, Good *Spaws*, *Hot Baths*, Mines of *Gold* and *Silver*, *Tinn*, *Copper*, *Lead* and *Iron*; they are some *Papists*,

pists,

pists, others *Protestants*, *Zwinglians*, *Calvinists*, and *Lutherans*. The Arms is *Sol*, an Eagle displayed with *two Heads*, *Saturn* armed, and Crowned *Mars*. There are six *Archbishops*, and 34 *Bishops*. They are a People much given to drinking; which made the Poet say——— §. 2. *Europe*.

Germani possunt cunctos tolerare labores;
O utinam possent tam bene ferre sitim.

The chief Cities of *Germany* are these, viz. *Strasborough*, *Cologn*, *Munster*, *Norimbergh*, *Ausburg*, *Numick*, *Vienna*, *Prague*, *Dresda*, *Berlin*, *Stetin*, *Lubeck*; Its chief Rivers the *Rhine*, *Weser*, *Elbe*, *Oder*, and the *Danow*, and Cities of *Bohemia*, are *Cutenberg*, and *Budrozu*.

Denmark and *Norway*, are two great Regions and bounded South with *Germany*; they have North Latitude 71° 30′, toward the East they border on *Sweden*; and elsewhere environed with the *Sea*. Their Commodities are *Oxen*, *Grain*, *Fish*, *Tallow*, *Sand*, *Nuts*, *Oyl*, *Hides*, *Goatskins*, *Fir-trees* for *Masts*, *Boards*, &c. *Pitch*, *Tarr* and *Brimstone*: they are *Lutherans*. The Order of Knighthood is that of the *Elephant*, their Badge a Coller powdered with *Elephants* Towred, supporting the Kings Arms; having appendent the Effigies of the *Virgin Mary*; the Arms of the Land are Quarterly. 1. *Or*, three *Lions* passant *Vert*, Crowned of the first, for the Kingdom of *Denmark*. 2dly, *Gules* a Lion Rampant, *Or*, Crowned and Armed of the first, in his Paws a *Dansk* hatchet; *Argent*, for the Kingdom of *Norway*. There are two *Archbishops*, and 13 *Bishops*; its chief City is *Coppenhagne*.

§. 2. *Sweden* is a mighty Kingdom, is bounded East with *Muscovia*, West with the *Dorfirin hills*,
Europe. North with the *Frozen Ocean*, and South with *Denmark*, *Liesland* and *Mare Balticum*; the Commodities are *Copper*, *Iron*, *Lead*, *Furr*, *Buff*, &c. They are brave Warriers, their Religion is *Lutherans*. The Arms *Azure* three Crowns *Or*, it hath two *Archbishops*, and eight *Bishops*.

Russia is bounded East with *Tartaria*, West with *Livonia* and *Finland*, North with the *Frozen Ocean*, and South with *Lituania*, and *Mare Caspium*. This Countrey is extreme cold: but yet Nature hath counterpoized it by supplying the Land plentifully with the best of *Furrs*, viz. *Sable*, *White-fox*, *Martin*, &c. It's subject to the Emperour of *Russia*; a vast Tract, and as wild a Government. The Inhabitants are *Base* and *Ignorant*, *Contentious* and *Foolish*, they deny the proceeding of the *Holy-Ghost*, they bury their Dead upright, with many other foolish Ceremonies; *Muscovia* is the Seat of the *Empire*. Its Commodities are *Furrs*, *Flax*, *Ropes*, *Hides*, *Fish*, and *Whales-grease*. The Arms are *Sable*, a *Portal* open of two Leaves, and as many degrees *Or*, they are of a mixt *Romish* Religion, not observing Learning as any thing: They have one *Patriarch*, two *Archbishops*, and eighteen *Bishops*. Its chief Cities are *Mucon*, *Wolodimax*, St. *Michael*, *Cazan*, and *Astracan*, it's chief Rivers are the *Dwine*, *Volaga*, and the *Tana*.

Poland is bounded South of *Moldavia* and *Hungary*; East with *Moscovia*, and *Tartaria*; West with *Germany*; and North with the *Baltick* Seas. The Commodities are *Spruce-Beer*, *Amber*,

Wheat,

Wheat, Rye, Hony, Wax, Hemp, Flax, Pitch,Tarr; §. 2.
it hath Mines of *Tinn* and *Copper*; their Religion is partly *Romish*, and partly of the *Greek-Church*, and so there are of the *Greek* Church, two *Archbishops*, and six *Bishops*, and of the *Romish Church* three *Archbishops*, and nineteen *Bishops*: The Arms are Quarterly. 1. *Gules* an Eagle *Argent* Crowned and Armed *Or*, for *Poland*, and two *Gules* a *Chevalier* armed *Cap-a-peid*, advancing his Sword *Argent*, Mounted on a *Barbed Course* of the Second, for the Dukedom of *Latuania*. Its chief Cities are *Cracovia*, *Warsovia*, *Damzerk*, *Vilna*, *Kion*, *Cameneca*, and *Smolensco*; and Rivers are *Vistula*, *Niemen*, *Dunæ* and the *Boristhenes*.

Europe.

Hungary is bounded East with *Transilvania*, and *Walachia*, West with *Stiria*, *Austria* and *Moravia*, North with the *Carpathian* Mountains, and South with *Sclavonia* and part of *Dacia*. The People are valiant, and shew their Antiquity to be *Scythians* by their barbarous Manners, and neglect of Learning Their Sons equally inherit without Priviledge of Birthright, and their Daughters portion is only a *New Attire*. Its Commodities are *Colours*, *Wheat*, *Beef*, *Salt*, *Wine* and *Fish*, the *German Emperour* and *Turk* hath it between them. The Arms is eight Barrs *Gules*, and *Argent*, they are some of the *Romish*, and others *Mahometans*. There are two *Archbishops*, and thirteen *Bishops*, and its chief Cities are *Transilvania*, *Valastia*, *Moldavia*, *Buda*, *Presbrough*, *Hermenstada*, *Tergoguis*, *Czuchan*, *Craffa* and *Bargos*. Its Rivers are the *Drin*, *Oxfeus*, *Peneus*, *Vardax*, *Marize* and the *Danubius*.

§. 2. *Sclavonia* is bounded South with the *Adriatick Seas*, East with *Greece*, North with *Hungary*, and West with *Carniola*. It is fruitfull of all those Commodities found in *Italy*, and is under several Governments, *viz.* *Turks*, *Venetians*, *Hungarians* and *Austrians*. The Arms are *Argent*, a Cardinals *Hat*, the strings *Pendant*, and Pleated in a True-lovers-knot, meeting in the Base *Gules*. They are some *Christians*, and some *Mahometans*. There are four *Archbishops*, and twenty six *Bishops*. Its chiefest Cities are *Nova*, *Zara*, *Nonigrad*, *Tinu*, *Sebenico*, S. *Nicolo*, *Trau*, *Spalato*, *Salona*, *Almisse*, *Starigrad*, *Vesicchio*, *Catara*, and *Doleigne*.

Europe.

Dacia is bounded East with the *Euxine Seas*, on the West with *Hungary* and *Sclavonia*, North with *Podolia*, and South with *Thrace*, and *Macedonia*. The Soyl is fruitfull in *Corn* and *Wine*. It yieldeth medicinal *Plants*, they have plenty of *Fowls*, both wild and tame, very Populous and of Nature like the *Hungarians*; they are all *Mahometans*; Its most famous Cities are *Triste* and *Pedena*.

Greece is bounded East with *Propontick Hellespont*, and *Ægean Seas*, West with the *Adriatick*, North with *Mount Hæmus*, and South with the *Ionian Seas*. It was once the Mother of Arts and Sciences, but now the very Den of the *Turkish Empire*. The Soyl is very fruitfull if well manur'd, which made the Poet say———

Impius hæc tam culta novalia miles habebit?
Barbarus has segetes? en queis consevimus arva!

Its Commodities are *Gold*, *Silver*, *Copper*, *Colours*,

lours, *Wines*, *Velvets*, *Damask*; here is the Mount of *Parnaſſus*: Here was the *Temple* of *Delphos*, conſecrated to *Apollo*; where the *Devil* through the *Oracle* did deceive the People, but after the Crucifixion of *Chriſt* the *Oracle* ceaſed. *Auguſtus* (ſaith *Suidas*, in whoſe time *Chriſt* was born) conſulting with the *Oracle*, received this Anſwer——— §. 2. *Europe*.

Παῖς ἑβρεῦς κέλεται με θεοῖς μακάρεσσιν ἀνάσσων
Τόν δε δόμον προλιπεῖν κ̀ ἀΐδλω ἄυθις ἱκέσθαι,
Λοιπὸν ἄπιθι σιγῶν ἐν βωμῶν ἡμετέρων.

An Hebrew Child, whom the bleſt Gods adore,
Hath bid me leave theſe Shrines, and pack to Hell,
So that of Oracle I can no more:
In ſilence leave our Altar, and farewell.

Their Religion is mixt but they are chiefly *Mahometans*. The Arms of this Empire were *Mars* a Croſs, *Sol*, between four *Greek Beta's* of the ſecond; *Bodin* ſaith the four *Beta's* ſignified Βασιλεὺς, Βασιλήων, Βασιλεύων, Βασιλεῦσι.

The moſt famous Cities in *Greece* are *Buda*, *Salonique*, *Adrianopolis*, *Scutary*, *Durazzo*, *La Valone*, L' *Armiro*, *Brevezza*, *Larta*, *Lepanto*, *Setines* or *Athens*, *Thebes*, *Corinth*, *Patras*, *Miſira* or *Lacædomia*.

I ſhall paſs over the Iſlands of *Sicily*, *Sardinia*, *Candia* and *Corſica*: and thus we have finiſhed the deſcription of the firſt part of the World, called by the Name of *EUROPE*.

§. 2.

Asia.

A S I A.

ASIA the second part of the World is bounded on the North with the *Northern Ocean*; South, with the *Red Sea*; East, with the *East Indian Ocean*; and on the West with the Flood *Tanais*. It is bigger than *EUROPE*, or *AFRICA*, and is far more rich, *Viz.* in *Pretious Stones*, and *Spices*, and hath been renowned by the first and second *Monarchs* of the *World*. Here Man was Created, placed in *Eden*, seduced by *Satan*, and redeemed by our *Blessed Saviour*. In it was done most of the History mentioned in the *Old Testament*. It hath been Ruled by the Kings of *China*, of *Persia*, the *Great Turk*, and the Emperour of *Rushia*, and contains these Provinces. *Viz. Anatolia*, *Cyprus*, *Syria*, *Palestine*, *Arabia*, *Chaldea*, *Assyria*, *Mesopotamia*, *Turcomania*, *Media*, *Persia*, *Tartaria*, *China*, *India* and the *Oriental Isles*.

Anatolia is bounded West with the *Thracian-Bosphorus*, *Helespont* and the *Ægean Seas*; East with *Euphrates*; North with the *Black Sea*; and South with the *Rhodian*, *Lydian* and *Pamphylian Seas*. Its length is 630, and breadth 210 miles; the Air is sound, the Soil fruitfull, but in some places desolate: it is inhabited by *Greeks* and *Turks*. It hath these Cities of note. *Viz. Anatolia*, *Bruce*, *Chiontai*, *Augoure*, *Trebisond*, *Sattalie*: and Rivers are *Alie*, *Jordan*, *Euphrates*, and *Tygris*.

Syprus

Sypras is bounded all round with the *Syrian* and *Sicilian Seas*; whoſe length is 200, and compaſs 550 miles. It is ſtored with plenty of all things, ſo that it wanteth no help of other Nations. Its Commodity is *Wine*, *Oyl*, *Corn*, *Sugar*, *Cotton*, *Honey*, &c. for which plenty of all things 'twas Conſecrated to *Venus*, as *Ovid* ſaith : §. 2. Aſia.

Feſta dies Veneris, tota celeberrima Cypro,
Venerat ; *Ipſa ſuis aderat* Venus *aurea feſtis.*

The People are *Warlike*, *Strong* and *Nimble*, and very hoſpitable to Strangers Their Arms are Quarterly. 1. *Argent*, a Croſs, Patent, betwixt 4 Croſſes *Or.* 2. Croſs-wiſe of 8 pieces *Argent*, and *Azure*, ſupporting a *Lion Paſſant*, *Azure* Crown'd *Or.* 3. A Lion *Gules.* 4. *Argent* a *Lion Gules* : they are of the *Popiſh* Religion, and have 2 *Archbiſhops* and 6 *Biſhops.*

Syria is bounded Eaſt with *Euphrates*; Weſt with the *Mediterranean Seas*; North with *Cilicia*; and South with *Paleſtine* and *Arabia.* Its length is 525 miles, and breadth 470. They are inhabited by *Mahometans*, *Chriſtians*, and *Pagans.* They are a ſtout and warlike people. In this Countrey there are ſaid to be Sheep whoſe Tails weigh ſome 30, and ſome 40 pounds ; the People are alſo *gluttenous*; it is almoſt overrun by the *Turks* : Its moſt famous Cities are *Aleppo*, *Te*, *Tripoly* and *Damal.*

Paleſtine is bounded Weſt with the *Mediterranean Seas*; Eaſt with the *Arabian Deſarts*; North with the *Anti-Libianus*; and South with *Arabia.* The Inhabitants are of a *middle ſtature*,

§. 2. *strong constitution*, yet a *stiffe necked* and *murmuring People* and *Idolaters*. In this is the Land of
Asia. *Canaan*, and the famous City *Hierusalem*, tho' now a *Den* of *Idolatrous Mahometans*. It abounds with all good things.

Arabia is bounded East with *Chaldea* and the *Gulph* of *Persia*; West with *Palestine*, *Ægypt*, and the *Red Sea*; North with *Euphrates*; and South with the *Southern Ocean*. The Inhabitants are *Mahometans*. *Job*'s Habitation was here. It yields *Frankincense*, *Pretious Stones*, &c. It is now under the *Great Turk*'s Sceptre. The most famous Cities are *Herac*, *Ava*, *Medina*, and *Mectar*: and it hath the famous River *Cayban*.

Chaldea is bounded East with *Susiana*; West with *Arabia Deserta*; North with *Mesopotamia*; and South with the *Persian Bay*. The Country is exceeding fruitfull; in it is supposed to have been the Garden of *Eden*; they were great *Southsayers*, and therefore flouted by the *Satyrist*.——

Chaldeis sed major erit fiducia, quicquid
Dixerit Astrologus, credent à fonte relatum
Ammonis, &c.

The Inhabitants are *stout* and *valiant*; they are *Mahometans*. Here *Julian* the *Apostate* breathed his Soul out to *Satan*, in these dying words, —— *Vicisti tandem Galilee*: the chief Cities are *Babylon*, *Bagdad*, *Balfora*, and *Sipparum*, with the famous River *Fazze*.

Assyria is bounded East with *Media*; West with *Mesopotamia*; South with *Susiana*; and North with *Turcomania* and *Chaldea*. This is a very

very plain and level Countrey, and very fruitfull, having good Rivers: the Natives are brave ſtout Warriours, formal in their Habit. It is under the *Turk*'s command, and governed by one of his *Baſſa*'s; who is able to bring into the Field at any time 100000 Souldiers: here are alſo a Sect of the *Neſtorians*, and fifteen *Chriſtian Churches*: its moſt famous Cities are *Calach*, *Cittace*, and *Arbela*. §. 2. *Aſia.*

Meſopotamia is bounded Eaſt with the River *Tigris*; Weſt with *Euphrates*; North with *Mount Taurus*; and South with *Chaldea*, and *Arabia Deſertæ*. It aboundeth with all good things neceſſary for the life of Man; they are *Mahometans*, and a people unable to defend themſelves but by the aſſiſtance of their Neighbours: It belongs to the *Mahometan Empire*. Its chief Cities are *Edeſſa*, and *Cologenbar*. I ſhall not deſcribe *Mount Taurus*, becauſe it is of no moment.

Turcomana is bounded Eaſt with *Media* and *Mare Caſpium*; Weſt with the *Euxine Seas*, *Cappadocia*, and *Armenia major*; North with *Tartaria*; and South with *Meſopotamia* and *Aſſyria*. It is a very mountainous Countrey; the people are handſome, ſtout and brave Warriours: the Women are good Archers. It hath *Gold* and *Silver Mines*: It yields *Grain*, *Fruit* and *Wine*; and in *Colchis* (a part thereof, and in *Aſſyria*) they ſell their Children: The Arms are the *Half Moon Or*. It is inhabited by *Mahometans*, and under the *Turkiſh Empire*. Its chief Cities are *Muſol*, *Bagded*, *Batſora*, *Sanatopdy*, and *Derbent*; with the famous River *Arais*.

Media

§. 2. *Media* is bounded East with *Parthia*; West with *Aremenia*; North with *Mare Caspium*; Asia. and South with *Persia*. The Countrey is of a large extent and very different, even to a Miracle, for in the North part it is cold and barren, their Bread is dryed *Almonds*, and Drink the Juice of *Herbs* and *Fruits*. Their Food is *Venison*, and other Wild Beasts, which they catch by hunting. And in the South side the Country is of a rich Soil, plentifull in *Corn*, *Wine*, &c. They have been brave Warriours, and it was a custom with them to poyson their Arrows, in an Oyl called *Oleum Mediacum*: they are *Mahometans*.

Persia is bounded East with *India*; West with *Media*, *Assyria*, and *Chaldea*; North with *Tartaria*; and South with the *Southern Ocean*. This is a mighty rich Countrey governed by the *Sephy*, the people are strong and valiant, and though *Mahometans*, yet they War with the *Turks* for the *Mahometan Religion* in expounding the *Alcoran*. From hence comes *Bezoars* and other pretious Stones, *Pearls*, and *Silk Works*. It hath these famous Cities with *Media*: Viz *Taurus*, *Gorgia*, *Cogsolama*, *Hysphan*, *Erat*, *Sus*, *Schiras*, and *Ormutz*: and these Rivers *Tiriditiri*, and *Bendimuz*.

Tartary bounded East with *China*, the *Oriental Ocean*, and the Straits of *Anian*; West with *Russia* and *Podolia*; North with the *Frozen Ocean*; and South with *China*. Now the *Tartarians* are divided into certain *Collonies*, and differ in manners and Trade of Living, and are Men of a Square Stature, broad Faces, and look a Squint; they are hardy and valiant; they will eat

eat either Horse-flesh or Man's Flesh. They drink Blood and Mares-milk; their Habit is very homely; they are some *Mahometans*, and some *Pagans*; their chief Commodity is rich *Furrs*, and they are governed by the great *Cham* of *Tartary*, and hath these famous Cities, *viz. Zabasp*, *Samarcanda*, *Thibet*, *Cambalu* and *Tatur*; and Rivers famous are *Joniscoy*, *Oby*, *Chezel* and *Albiamu*. §. 2. *Asia.*

China is bounded East with the *Oriental Ocean*; West with *India* and *Cathay*; North with *Altay* and the *Eastern Tartaries*; and South with *Canchin-China*. It hath 591 *Provinces*, 1593 *Walled Towns*, 1154 *Castles*, 4200 *unwalled Towns*, and such an infinite Number of *Villages*, that the whole Countrey seems as one *Town*. It is reported that the *Prince* can bring into the Field 300000 Foot and 200000 Horse. The Land is fruitfull in *Grain*, full of wild and tame *Beasts*, it yields *Silk*, *Pretious Stones*, *Gold*, *Copper*, &c. The People are ingenious and great Artists, Witness their *Wagon* made to sail over the Land driven by the Wind: and Historians tells us, that the Art of *Printing* and of making *Guns*, is more Ancient with them than with us. They are *Idolaters* and worship the *Sun*, *Moon* and *Stars*, also they worship the *Devil* himself, that he may not hurt them. And it hath these most famous Cities, *viz. Paguin*, *Quinjay*, *Caneun*, *Macao*, *Mancian* and *Magaia*, with the great River *Quinam*.

India is bounded East with the *Oriental Ocean*, and part of *China*; West with the *Persian Empire*; North with *Mount Taurus*; and South with the *Indian Ocean*. This Countrey hath an

Exact

§. 2. Exact temperature of Air; two *Summers* and a double encrease, blest with all things neces-
Asia. sary for the Life of Man. It hath Mines of *Gold* and *Silver*, *Pretious Stones*, *Spices*, and *Medicinal Druggs*, abundance of *Cattle*, and *Cammels*, *Apes*, *Dragons*, *Serpents*, also multitude of *Elephants*; a Creature of a vast Bigness, some of which are said to be nine *Cubits* high, and as many long, and five *Cubits* thick. It is a Creature of wonderfull Sence: for 'tis reported of the *Elephant* on which King *Phorus* sate in the Warrs of *Alexander*, finding his Master strong and lusty, rushed boldly into the thickest of the Enemies Army: But when he once perceived him to be faint and weary, he withdrew himself out of the Battel, kneel'd down, and into his own *Trunck* received all the Arrows, directed at his Master. It also is of a most prodigious strength, for it is reported to carry a *Wooden Tower* on his Back, with thirty fighting men besides the *Indian* that Rules him. The Sea yields variety of *Pearls* and *Fish*; here is also the *Leviathan* or *Whale*, of which *Pliny* says there are some of 960 Foot long; here is the *Rhinoceros* also found: (such as hath of late been publickly shewed at the *Bell-savage Inn* on *Ludgate-hill* in *London*) a deadly and cruel Enemy to the *Elephant*, for though he be less, yet he will whet his horn against the *Rocks*, and then therewith strive to rip up the *Elephants* Belly, and is by many Naturalists supposed to be the *Unicorn*, for all the parts of his Body, especially his Horn, is a soveraign Antidote against Poyson. This Countrey is inhabited by *Indians*, *Moors*, *Arabians*,

Jews,

Jews, *Tartars* and *Portugeze*. The Natives are *Tawny*, *tall* and strong, and very punctual to their word. They eat no *Fish* nor *Flesh*, but live on things without life; being *Pythagoreans*. It is also reported that when the Husband dies, and is burning on the Funeral Pile, that then the Wife leaps into the Fire, and so the living and the dead burn together, which made the Poet say——— §. 2. *Asia.*

Et certamen habent lethi, quæ viva sequatur,
Conjugium; pudor est non licuisse mori.
Ardent victrices, & præbent pectora flammæ,
Imponuntque suis ora perusta viris.

In *India* these are the chief Cities, *viz.* *Amedabur*, *Cambaia*, *Gouro*, *Diu*, *Bengala*, *Pangab*, *Agra*, *Goa*, *Calicut*, *Visnagor*, *Pegu*, *Arracan*, *Malaca*, *Camboge*, and *Faefo*. The fairest Rivers are *Indus*, *Ganges* and *Mecon*.

The *Oriental Islands* are these, *viz.* 1. *Japan*, 2. The *Phillepinæ Isles*, 3. The *Maluccose*, 4. *Bantam*, 5. The *Selebes*, 6. *Borneo*, 7. The Isles of *Java*, 8. *Sumatra*, 9. *Zeiland*, and other lesser Isles of which we shall not treat.

1. *Japan* is a rich Island abounding with *Gold*: So that *Paulus Ventius* saith, that in his time the King's Palace was covered therewith. It is a Mountainous Countrey, a healthfull Air; here the Wheat is ripe in *May*. It's full of Woods of tall *Cedars*, abundance of *Beasts*, Wild and Tame; and also *Fowls*. The Inhabitants are *strong*, and *witty*, and have but one Language. They are *Christians*, and *Idolaters*, and the chief Cities are these, *viz.* *Bungo*, *Meaco* and *Saeay*. The

§. 2. The *Phillipine Isles* are in Number 40, called so in honour to *Philip* II. King of *Spain*, and are now inhabited by the Natives, and *Spaniards*, they are in a good Air and stored with rich Commodities; and in them are these Cities, *Lusor*, *Manille*, and *Mindanao*.

Asia.

The *Moluccoes* Islands are many in Number, their Commodity is *Cinnamon*, (which grows in whole Woods; it is the Bark of a Tree, stript and laid in the Sun till it looks red; and in three years time the Tree receives his Bark again.) *Ginger*, *Nutmegs*, *Mastick*, *Aloes*, *Pepper* and *Cloves*: now the *Clove* groweth on a Tree like a *Bay Tree*; yielding blossoms first white, then green, and at last red and hard, and then are Cloves. In it is also found the Bird of *Paradice*, and no where else, which for the strangeness and fairness of Feathers exceeds all the Birds in the World. The People are *Pagans*. Here is a *Mountain* of a prodigious height, above the Clouds, and agreeing to the Element of Fire, which it seems to mount unto, through Flames; wherewith, a dreadfull Thunder, and a dark Smoak it sends forth continually.

The Isles of *Bantam* are in Number seven, one of which is continually burning, the Inhabitants are *Barbarous*, *Weak of Bodies*, *Slothfull*, *Dull*, and lying most confusedly together, without Rule, and are *Mahometans*. Its Commodities are *Nutmegs*, and both the *yellow and white Saundersses*. Now the *Nutmeg* grows on a Tree like a *Peach Tree*, the innermost part of whose Fruit is the Nutmeg, and is covered over with a Coat which ripe is called *Mace*; they yield their Fruit thrice in the Year, to wit, at *April*, *August* and *December*.

The

The *Selebes* are a Number of Isles full of *Barbarous* People, and *Man-Eaters*, they have abundance of strange Birds: It yields *Sugar*, *Cocanuts*, *Cloves*, *Oranges*, &c. In some of these Isles they make *Bread* of the *Pith*, and *Drink* of the Juice of the Tree called *Sagu*: It hath these chief Towns, *viz*. *Senderem* and *Macassar*. §. 2. *Asia*.

Borneo lieth West of the *Celebes*, and is in compass 2200 Miles, the Countrey yields *Asses*, *Oxen*, *Herds of Cattle* and *Horses*. It yields *Camphire*, *Agarick*, and *Mines* of *Adamants*: They think the *Sun* and *Moon* to be *Husband* and *Wife*, and the Stars *their Children*, they reverently salute the *Sun* at his first rising. Their Affairs of State they Treat of in the Night, at which time the *Councellor of State* meets, and ascends some Tree, viewing the Heavens till the *Moon* ariseth, and then they go to their *House of State*. In it are these Towns, *viz*. *Borneo*, *Taiopura*, *Tamaoratas*, *Malno* and *Sagadana*. It is under the Government of the Kings of *Borneo* and *Laus*; the People are *Idolaters*.

Java Major, and *Java Minor*, are two Islands opposite to *Borneo*. They have plenty of *Fruits*, *Grains*, *Beasts*, *Fish* and *Fowls*, *Gold* and *Pretious Stones*. The Natives are of a middle Stature, broad faced and tawny, their Religion *Mahometans*, and they will eat their nearest of kin: the chief Town is *Panarucan* near a burning Hill, which in 1586 broke forth, and cast huge Stones into the City for three Days together, and destroyed much People. From the top of this vast high Mountain the *Devil* environed with a white and shining Cloud, doth sometimes shew himself unto his Worshippers, which live about those Hills. *Su-*

§. 2. *Sumatra* lieth North of *Java Major*, betwixt it and the ſtraits of *Sincapura*, its length is 900 Miles, and breadth 200; it is full of Fenns and Rivers, with thick Woods, and hath a very hot Air; it is not fruitfull in *Grain*. Its Commodities are *Ginger*, *Pepper*, *Agarick*, *Caſſia*, *Wax*, *Honey*, *Silk*, *Cotten*, *Iron*, *Tinn* and *Sulphur*. It hath alſo Mines of *Gold*, and is ſuppoſed to be *Solomon's Ophyr*. The King's Furniture of his Houſe, and Trapping for his *Elephants* was beaten *Gold*, and he intituleth himſelf King of the *Golden Mountains*. Here is the notable Mountain *Balalvanus*, ſaid to burn continually; out of which or not far off do ariſe two Fountains, the one is ſaid to run *pure Oyle*, and the other *Balſamum Sumatra*; the People are *Mahometans*. The chief City and Seat of the King is *Achen*, beautifyed with the Royal Pallace, to which you paſs through ſeven Gates one after another, with green Courts betwixt the two outermoſt; which are guarded with *Women*, that are expert at their Weapons, and uſe both *Sword* and *Guns* with great dexterity, and are the only Guard the King hath for his Perſon. The Government is *Abſolute* and *Arbitrary*, merely at the King's pleaſure.

Aſia.

Zeiland lies Weſt of *Sumatra*, it is a good Soyl, and yields theſe Commodities, *viz*. *Cinnamon*, *Oranges*, *Lemmons*, moſt delicate fruit, *Gold*, *Silver* and *Pretious Stones*, it's full of *wild and tame Beaſts*, *Fiſh and Fowls*, yet deſtitute of the *Vine*: the People are ſtrong and tall, given to *Eaſe* and *Pleaſure*, and are in general *Mahometans*. The chief Towns are *Candia*, *Ventane*, and

and *Janasipata*. They have Fish-shells passing currant for money, there are other lesser Isles which we do for brevity sake omit, and thus we have done with the description of the second part of the World called *ASIA*. §. 2. *Asia*.

AFRICA.

Africa.

A*FRICA* the third part of the World is bounded East with the *Red-Sea*; West with the *Atlantick-Ocean*; South with the *Southern-Ocean*; and North with the *Mediterranean Sea*; and contains these Provinces, *viz.* *Egypt*, *Barbary*, *Numidia*, *Lybia*, *Terra-Nigritarum*, *Æthiopia-superior* and *Æthiopia-inferior*, with the *Islands* thereto belonging. Its Commodities are *Balm*, *Ivory*, *Ebony*, *Sugar*, *Ginger*, *Dates*, *Myrrh*, *Feathers*, &c.

Egypt is bounded East with *Idumea*, and the Bay of *Arabia*; on the West with *Barbary*, *Numidia*, and *Lybia*; North with the *Mediterranean Sea*; and South with *Æthiopia-superior*. Its length is 562 Miles, and breadth 160. The Natives are of a *Tawny* Complection, their Wives are the Merchants, whilst the Husband attends the Houshold Affairs. They were the Inventers of *Mathematical Sciences*; they were also *Magicians*, and are still endued with a special Dexterity of Wit: They worship in every Town a particular God, but the God by them most adored was *Apis*. This Land is very fruitfull

§. 2. in all manner of *Cattle*, *Cammels*, and abundance of *Goats*; they have plenty of *Fowls* both wild

Africa. and tame: It hath *Metals* and *Pretious Stones*, *Good Wines* and rare Fruits, as *Oranges*, *Lemmons*, *Cittons*, *Pomgranets*, *Figgs*, *Cherries*, &c. Here also groweth the *Palm-Tree*, which grow the *Male* and *Female* together; both put out *Cods* of Seeds, but the Female is not fruitfull unless she grow by the Male, and have her Seed mixt with his. The *Pith* of this Tree is good for *Sallads*, of the Wood they make *Bedsteads*, of the *Leaves Baskets*, *Mats*, and *Fanns*, of the outward husk of the fruit *Cordage*, of the inward *brushes*. Its fruit is the *Dates*, good for food, and finally 'tis said to produce all things necessary for the Life of Man, and its Branches are worn in token of *Victory*, as saith *Horace*.

——Palmaque nobilis,
Terrarum Dominos evebit ad Deos.

It hath many other Rarities which I am forc'd to omit. In it are these famous Cities, *viz.* *Sabod*, *Cairo*, *Alexandria*, *Raseba*, *Damietta*, *Cosir* and *Surs*, with the famous River *Nilus*, which by its overflowing makes the Land fertile, according to that of *Lucia.*———

Terra suis contenta bonis, non indiga mercis,
Aut Jovis; in solo tanta est fiducia Nilo.

Barbary is bounded East with *Cyrenaica*; West with the *Atlantick-Ocean*; North with the *Mediterranean*, the Straits of *Gibralter*, and part of the *Atlantick-Ocean*; and on the South by *Mount-*

Mount Atlas. It is full of *Hills* and *Woods*, sto- §. 2.
red with *Wild Beasts*: as *Lyons*, *Bears*, &c.
Large Herds of *Cattle*; it hath *Dragons*, *Leopards*, *Africa.*
and *Elephants*; beautifull, swift, and strong *Horses*; it is the fruitfullest Countrey in the World in some parts of it; for *Pliny* saith that not far from the City *Tacape*, you shall see a great *Palm-Tree* overshadowing an *Olive*; under that a *Figg-Tree*; under that a *Pomgranat*; under that a *Vine*; and under all *Pease*, *Wheat* and *Herbs*, all growing and flourishing at one time, which the Earth produceth of it self: Its length is 1500 Miles, and breadth 300 Miles, the Natives are of a *Tawnyish Colour*, *rare Horsemen*, *crafty* and *unfaithfull*, and above measure *Jealous* of their *Wives*. It contains these Kingdoms, *Viz. Tunis*, *Algiers*, *Morocco* and *Feze*, and it hath these *Isles*, *Viz. Pantalaria*, *Carchana*, *Zerby*, *Gaulos* and *Malta*, the two latter of which Isles are inhabited by *Christians*, and are of the *Romish* Religon; but for the other parts of *Barbary*, they are either *Mahometans* or *Pagans*. The most famous Cities are *Morocco*, *Feze*, *Tangier*, (which formerly was a Principal City of *Barbary*, but is now demolisht and lain level with the Ground, by the Command of His late *Majesty Carolus* II. of blessed Memory, and performed by the indefatigable skill and industry of the right *Honourable George Lord Darmouth Anno*, 1683.) *Teleusin*, *Oran*, *Algier*, *Constantine*, *Tunis*, *Tripoly* and *Barca*, with these famous Rivers, *Ommiraby* and *Magrida*.

Mount Atlas is a ridge of Hills of no small length, but of an exceeding heighth, above the Clouds, and is always covered with *Snow*,

§. 2. *Summer* and *Winter*, full of thick Woods, and against *ASIA* so fruitfull, that it affords excellent Fruit of it's natural growth; it received

Africa. it's Name from *Atlas* a King of *Mauritania*, feined by the Poets to be turned into that Hill, by the Head of *Medusa*; he was feigned to be so high that his Head touched Heaven: The ground of this Fiction I suppose was from his extraordinary knowledge in *Astronomy*, which *Virgil* seems to intimate——

Jamque volans apicem & latera ardua cernit
Atlantis duri, Cælum qui vertice fulcit.

Numidia is bounded East with *Egypt*; West with the *Atlantick-Ocean*; North with *Mount Atlas*; and South with *Libia Deserta.* The Natives are a wandring and unstable People, for they spend their Lives in Hunting, and continue not above four or five Days in one place, but so long as it will graze their *Camels.* Here grow abundance of *Dates*, with which they feed themselves, and with the Stones fat their *Goats.* The Air here is so sound that it will cure the *French-Pox* without any Course of *Physick.* They are *Mahometans*: its chief Provinces are *Dara*, *Pescara*, *Fighig*, *Tegorarin* and *Biledulgerid*; and its chief Cities are *Taradath*, *Dara* and *Zeb*; they belong to the Scepter of *Morocco.*

Lybia is bounded North with *Numidia*; East with *Nuba*; South with *Terra-Nigritarum*; and West with *Gualata.* This is well termed a Desart, for in it may a man travel eight or ten Days and not see any Water, nor Trees,

Trees, nor Grafs. So that Merchants are for- §. 2.
ced to carry their Provifion with them on *Ca-*
mels, which if it fails they kill their *Camels*, *Africa.*
and drink the Juice of their Entrails. It contains thefe Provinces, *Viz. Zahaga, Zvenziga, Targa, Lembta* and *Bordea*. They are governed by the chief of the *Clans*, and are a People only differing from *Brute-Beafts*, by their Shape and their Speech.

Terra Nigritarum is bounded Eaft with *Ethiopia-fuperior*; Weft with the *Atlantick-Ocean*; North with *Lybia*; and South with the *Ethiopick-Ocean*. The Countrey is under the *Torrid-Zone*, full of People, and moft exceffive hot; the foyl is exceeding fruitfull, brave Woods, Multitudes of *Elephants* and other *Beafts*: they have Mines both of *Silver* and *Gold*, very fine and pure; the Natives are *Cole-Black*, or very *Tawny*, and are now fome of them *Mahometans*, but moft of them *Pagans*. It hath now thefe Provinces, *Viz. Ora, Anterofa, Gualata, Agadez, Cano, Cafena, Sanaga, Gambra, Tombrutum, Melli, Gheneoa, Guber, Gialofi, Guinea, Benin, Guangara, Bornum* and *Goaga*, (in which groweth a *Poyfon*, which if any eateth but the tenth part of a Grain it will end his Days) *Bito, Temiano, Zegzeg, Zanfara, Gothan, Medra* and *Daum*. And in it are thefe moft remarkable Cities: *Gue, Eata, Gueneba, Tomta, Agados, Cuffena, Tuta, Waver* and *Sanfara*. The Rivers here that are moft famous are *Sernoga, Cambua* and *Rio-Degrand*.

Æthiopia-fuperior is bounded Eaft with the Red-Sea, and *Sinus-Barbaricus*; Weft with *Lybia-inferior*, *Nubia*, and *Congo*; North

 with

§. 2. with *Egypt*, and *Lybia Marmarica*; and South with *Monta-Luna*. Now its length is ſaid to be 1500 Miles, and Circute 4300. It is under the Command of the *Abaſſine Emperour*: here the Air and Earth is ſo hot and pieircing, that if the Inhabitants go out of their Doors without Shoes they loſe their Feet; here they alſo roaſt their Meat with the *Sun*: they have ſome grain, their Rivers are almoſt choaked up with *Fiſh*, their Woods ſtuffed with *Deer*, yet they will not trouble themſelves to catch them. The Inhabitants are *Lazy* and deſtitute of all *Learning*, they are of an *Olive Tawny*: here is alſo a *Fountain*, that if a man drinks thereof he either falleth mad, or elſe for a long time is troubled with a continual *Drowſineſs*, of which *Ovid* thus ſpeaks——

Africa.

Æthiopeſque Lacus; quos ſi quis faucibus hauſit,
Aut furit, aut patitur mirum gravitate ſaporem.

And it contains theſe Provinces, *Viz. Guagere*, *Tigremaon*, *Angote*, *Amara*, *Damut*, *Gojamy*, *Bagamedrum*, *Barnagaſſe*, *Dancali*, *Dobas*, *Adel*, *Adea*, *Fatigar*, *Xoa* and *Barus*. Now as for the Government of theſe Empires 'tis merely Regal: here is the Order of St. *Anthony*, to which every Father that is a Gentleman, is to give one of his Sons: out of which they raiſe about 12000 Horſe, which are to be a ſtanding Guard of the *Emperour*'s Perſon: their Oath is to defend the Frontiers of their *Kingdom*, to preſerve *Religion*, and to root out the Enemies of their *Faith*; the Principals of their Religion are theſe. Firſt, they circumciſe their Children both *Males* and

and *Females*. Secondly, they Baptize the *Males* at 40 and *Females* at 80 Days after Circumcision. Thirdly, after the *Eucharist* they are not to spit till Sun-set. Fourthly, they profess but one Nature and one Will in *Christ*. Fifthly, they accept but of the three first general Councils. Sixthly, the Priests live by the own labour of their hands, and are not to beg. Seventhly, they baptize themselves every *Epiphany* in *Lakes* or *Ponds*, because that Day they say *Christ* was baptized by *John* in *Jordan*. Eighthly, they eat not of those Beasts which *Moses* pronounced unclean, keeping the *Jews Sabbath*, with the *Lord's Day*. Tenthly, they administer the *Lord's Supper* to *Infants* presently after *Baptism*. Eleventhly, they teach the Reasonable Soul of Man comes by *Seminal Propagation*. Twelfthly, that *Infants* dying *unbaptized* are saved, being sanctifyed by the *Eucharist* in the Womb, and finally they produce a Book of Eight Volumes, writ as they say by the *Apostles* at *Jerusalem* for that purpose, the Contents whereof they observe most solemnly, and thus they differ from the *Papists*. § 2. *Africa.*

Now the chief Cities in this *Empire* are these, *Viz. Barone*, *Caxumo*, *Amarar*, *Damont*, *Cefates*, *Narre*, *Goyame*, and *Adeghena* with the famous Rivers *Zaire* and *Quilmanei*.

Æthiopia-inferior is bounded East with the *Red-Sea*; West with the *Æthiolick Ocean*; North with *Terra-Negritarum*, and the higher *Æthiopy*; and South with the *Main Ocean*. And it contains these Provinces, *Viz. Zanzibar*, *Monomotapa*, *Cafravia*, and *Manigongo*. The Natives are Black, with curled Hair, and are *Pagans*.

§. 2. In it are great Herds of Cattle, abundance of *Deere*, *Antelopes*, *Baboons*, *Foxes*, *Hares*, *Ostriches*, *Pelicans* and *Herons*, and in a Word what else is necessary for the Life of Man. In it are these most famous Cities, *Viz.* *Banza*, *Loanga*, S. *Salvador*, *Cabazze*, *Sabula*, *Simbaos*, *Butua*, and *Tete*. The Rivers are *Cuama*, *Spiritus Sancto*, and *Dos Infante*.

Africa.

The Islands in *AFRICA* are these, *Viz.* the *Æthiopick-Isles*, *Madagascar*, *Socofara*, *Mohelia*, *Mauritius*, St. *Helens*, the *Isles of Ascention*, St. *Thomas-Isles*, the *Princes-Isles*, the *Isles of Annibon*, the *Isles of Cape d' Verd*, the *Canaries*, *Madera*, *Holyport* and the *Hesperides*. The Description of all which I am forced to omit because I have been so very large in the Description of the third part of the World called *AFRICA*.

AMERICA.

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§. 2.

AMERICA.

America.

AMERICA, the fourth part of the World, was first discovered by *Christopher Columbus*, *Anno* 1492, but it hath received its Name from *Americus Vesputius*, who in the year of Christ 1597 did sail about it. Now this fourth part of the World is bounded East with the *Atlantick Ocean*; West with the *West-Indian Ocean*; South with the *Magellanick Sea*; and on the North with the *Northern Ocean*.

When first the *Spaniards* had entred on *America* they found the people without Apparel, and their Bread was made of the *Jucca-Root*, whose Juice is a strong poyson: but it being squeezed out and dried it makes Bread. They worshipped *Devillish Spirits*, which they call *Zema*; in remembrance of which they keep Images made of Cotton Wool, to which they did great reverence, supposing the Spirits of their Gods were there; and to blind them the more, the Devil would cause these *Puppets* to seem to move and to make a noise, so that they feared them so greatly that they durst not offend them; which if they did, then the Devil would come and destroy their Children. They were so ignorant that they thought the *Spaniards* to be immortal; but the doubt continued not long, for having taken some of them Prisoners, they put them under Water untill they were dead, and then they knew them to be mortal like

§. 2. like other Men. They were quite destitute of all good Learning, reckoning their Time by a

America. confused knowledge of the course of the *Moon*; they were honest and kind in their Entertainments, encouraged thereunto by an Opinion that there was a certain place to which the Souls of those that so lived, and dyed for the defence of their Countrey, should go to, and there be for ever happy. So natural is the knowledge of the Soul's Immortality, and of some *Ubi*, for its future reception, that we find some tract of it in the most *Barbarous Nations*. The *Americans* were of a fair and clear Complexion. This Countrey is very plentifull in *Spices*, and *Fruits*; and such Creatures which the other parts never knew: So full of *Cows* and *Bulls*, that the *Spaniards* kill thousands of them yearly only for the *Hides* and *Tallow*. Blest with abundance of *Gold*, that in some Mines they have found more *Gold* than *Earth*. They have *Grey Lyons*, their *Dogs* snowted like *Foxes*, neither can they bark; their *Swine* hath *Talons* sharp as *Razors*, and their *Navel* on the ridges of their *Backs*; the *Stags* and *Deer* without Horns; their *Sheep* are so strong that they make them carry burthens of 150 pound weight; they have a Creature with the forepart as a *Fox*, and hinder as an *Ape*, except the Feet which are like a *Man*'s; beneath their Belly is placed a Receptacle like a *Purse*, in which their young remains till they can shift for themselves, never coming thence but when they suck and then go in again. The *Armadilla* is like a barbed *Horse*, armed all over with *Scales* that seem to shut and open. The *Vieugue* resem-

resembling a *Goat*, but bigger, in whose Belly is found the *Bezoar*, good against Poyson. A Hare having a Tail like a *Cat*, under whose Skin nature hath placed a *Bagg*, which she useth as a *Store-house*: for having filled her self she putteth the residue of her provision therein. *Pigritia*, a little Beast that can go no further in fourteen days than a Man will cast a Stone. For their *Birds* they are of such variety of *Colours* and *Notes*, which are so rare and charming, that they surpass all other *Birds* in any other parts. §. 2. *America.*

Now *America* is divided into two parts, *viz. Mexicana*, whose compass is said to be 13000 miles, and that other part called *Peruana*, whose *Circumnavigation* is esteemed 17000 miles. The Provinces of *Mexicana* are these: Viz. *Estotilant*, *Canada*, *Virginia*, *Florida*, *California*, *Nova-Gallicia*, *Nova-Hispania*, and *Guatimala*. *Peruana* contains these *Provinces*: *viz. Castella-Aurea*, *Nova-Granado*, *Peru*, *Chile*, *Paragnay*, *Brasila*, *Guiana*, and *Paria*. To *Peruana* belongs these principal Isles: *viz. Hispaniola*, *Cuba*, *Jamaica*, *Porto-Rict*, *Barbadoes*, the *Charibe-Isles*, *Insula-Margaretta*, *Molaque-Isles*, *Remora*, *Insula Solamnis*, and some other small Isles. But first of *Mexicana*.

Estotilant hath on the East the *Main Ocean*; South *Canada*; West *Terra Incognita*; and North *Hudson's Bay*. It comprehends *Estotilant*, so principally called, *Terra Corterialis*, *New-found-land*, and the Isles of *Baccalaos*. It is well stockt with all things necessary for the life of Man: the Natives are barbarous, fair, swift of Foot, and good Archers. They are *Pagans*.

Canada

§. 2. *Canada* is bounded North with *Cortelialis*; South with *New England*; East with the *Main*
America. *Ocean*; and West with *Terra Incognita.* It contains these several Regions: *viz. Nova Francia*, *Nova Scotia*, *Norumbegne*, and four small *Isles* adjoyning thereto. The people when first discovered were very rude and barbarous, going Naked only a piece of Fishes Skin to cover their private parts, and had two or three Wives a piece, which never Marry after the death of their Husbands. The Soil is fruitfull, and yields all manner of good things. Here groweth the *Sea Horse* whose Teeth is an *Antidote* against *Poyson.* It hath these principal Cities: *viz. Hochelaga* and *Quebeque.*

Virginia hath North *Canada*; South *Florida*; East *Mare-del-Noort*; West with *Terra Incognita.* And it is now divided into *New England*, *New Belgium*, and *Virginia* strictly so called. It is in some parts (yea most parts) Mountainous, Wooddy and Barren, and full of Wild Beasts. It yields plenty of *Cattle*, wild and tame *Fowls.* Its Commodities are *Furrs*, *Amber*, *Iron*, *Ropes*, *Tobaco*, *Sturgeon*, &c. The Natives are but few in number, and those very different both in Speech and Size, to a Miracle: those whom they call *Sasques Honoxi*, are to the English as Giants clad in *Bears Skins*; those whom they call *Wigcocomici*, are as Dwarfs; for the most part without Beards; they hide their nakedness with a Skin, the rest of their Body they paint over in the figures of horrid Creatures. The chief Towns are *James's*, and *Plimouth*, and Isle of *Bermoodus*, which I here omit.

Florida

Florida is bounded North-East with *Virginia*; East with *Mare-del-Noort*; South with the *Gulph* of *Mexico*. It was first discovered by the *English*, *Anno* 1497. The Soil is very fertile in Grain and Fruit, Beast wild and tame, and so also for Fowls: It yields lofty *Cedars*, and *Sassafras*: It hath *Gold* and *Silver* Mines, and also *Pearls*. §. 2. *America*.

The Natives are of an *Olive-Colour*, strong and fierce, and are clad like the former Natives of *America*. The Women when their Husbands are dead cut off their Hair, and cannot Marry till their Hair is grown out again. To it belongs these Islands: *viz.* the Isles of *Tortugas*, *Martyres*, and *Lucaios*: there are also about 24 small ones more which are insignificant. The Women here are most extreamly beautifull; the Natives are *Pagans*. Its chief Towns are St. *Helens*, *Ax Carolina*, and *Port-Royall*.

Califormia is an Island having on the West *New Spain*, and *New Gallicia*; and so unto those undiscovered parts which lie furthest North, to the Straits of *Anian*; and 'tis divided into these four parts: *viz. Quivira*, *Cibola*, *California*, specially so called, and *Nova Albion*. All which Countreys are indifferent fruitfull, full of Woods, and both wild and tame Beasts; plenty both of Fish and Fowl wild and tame: They worship the *Sun* as their chief God: They go naked both Men and Women in some parts, others are half way cloathed; and so very various that I cannot in this small Tract describe them. Its chief Town is *Chichilticala*. And here I cannot chuse but remark that in *Quivira* their Beasts are of strange forms, and are to them both *Meat*, *Drink* and *Cloathes*.

For

§. 2. For the *Hides* yields them *Houses*; their *Bones* and *Hair*, *Bodkins* and *Thread*; their *Sinews*,
America. *Cords*; their *Horns*, *Guts* and *Bladders*, *Vessels*; their *Dung*, *Fire*; their *Calveskins*, *Buckets* to draw and keep Water in; their *Blood*, *Drink*; and their *Flesh*, *Meat*; and so much for *California*.

Nova Gallicia is bounded East and South with *Nova Hispania*; West with the River *Buena*, *Guia*, and the *Gulph Californmia*; and North with *Terra Incognita*. It comprehendeth these Provinces: *viz.* *Chialoa*, *Contiacan*, *Xalisco*, *Guadalajara*, *Zacatecas*, *New Biscay*, and *Nova Mexicana*. In which Provinces the Air is indifferently temperate, yet sometimes given to Thunder, Storms, and Rain. It is full of Mountains, yields *Brass*, *Iron*, &c. They have plenty of *Fish*, *Beast*, *Fowls*, *Fruit*, and abundance of *Honey*. The Natives are wavering, crafty and lazy, given to singing and dancing. They go not naked: they are subject to the King of *Spain*. Its chief Cities are *Guadalajara*, and St. *John's*.

Nova-Hispania is bounded East with the *Gulph* of *Mexico*, and the Bay of *New-Spain*; West with *Nova Gallicia*, and *Mare-del-Zur*; on the North with part of *Nova Gallicia*, and part of *Florida*; and on the South with the *South Sea*. It comprehendeth these Provinces: *Viz.* *Mexicana*, *Mechoacan*, *Panuco*, *Trascala*, *Guaxata*, *Chiapa* and *Jucutan*. In all which the Air is healthfull and temperate, rich in Mines of *Gold* and *Silver*, *Cassia*, *Coccineel*, which grows on a shrub called *Tuna*, yields grain, and delicate Fruit, *Birds* and *Beasts* both *Wild* and

Tame,

Tame : their Harveſt is in *October* and in *May*. §. 2.

The Natives are witty and hardy, yet ſo ignorant that they thought the *Spaniſh-horſe* and *Man* to have been but one Creature, and thought when the Horſes Neighed they had ſpoken. The *Spaniards* whoſe Cruelties will never be forgotten, did in leſs than 17 years kill of the Natives 6000000; here is a Tree called *Meto*, it bears 40 kinds of Leaves, of which they make *Conſerves*, *Paper*, *Flax*, *Mantles*, *Matts*, *Shoes*, *Girdles*; it yields a *Juce* like *Syrup*, which boyled becomes *Hony*, if purified *Sugar*; the *Bark* roaſted is a good *Emplaiſture for Punctures* or *Contuſions*; and it yields a *Gum* Sovereign againſt *Poyſon* : here is alſo a Burning Mountain called *Fropæampeche*, which ſends forth two ſtreams the one of *Red* and the other of *Black Pitch*: the Inhabitants are *Pagans*. *America.*

Guatimala is bounded North with *Jacuta*, and the *Gulph Honduras*; South with *Mare-del-Zur*; Eaſt with *Caſtella-Aurea*; and Weſt with *New Spain*. The Soyl and People are as in *Nova Hiſpania* : it contains theſe Provinces, *Viz*. *Chiapa*, *Verapaz*, *Guatimala*, *Hondarus*, *Niceragna* and *Teragna*. And Towns of moſt Note are *Cutrinidao* and St. *Michael's*, the People are *Pagans*. And ſo much for *Mexicana*.

Peruana the Second Part of *AMERICA*, ſo called from *Peru* a Place of Note therein, and it doth contain theſe Provinces, *Viz*. *Caſtella-Aurea*, *Nova-Granada*, *Peru*, *Chile*, *Paragnay*, *Braſile*, *Guyana*, and *Paria* and its *Iſles*. But ſuch *Iſles* that fall not properly under ſome of theſe muſt be referred to the general Heads of the *American Iſlands*. *Caſtel-*

§. 2. *Castella-del Oro*, is bounded East and North with *Mare-del-Noort*; West with *Mare-del-Zur*; *America.* and South with *Granada*. And it containeth these Provinces, *Viz. Panama, Darien, Nova-Andaluzia*, St. *Martha* and *De-la-Hacha*. In all which Provinces the Air is very hot and unhealthfull: the Soyl either Mountainous and Barren, or low and Miry: plenty of Beast and Fowls. Here is said to be a Tree which if one touch he is poysoned to death: the old Natives are now almost quite rooted out. Its chief City is *Carthagena*, which Sir *Francis Drake* in 1585 took by Assault. This Land hath abundance of *Gold*.

Nova-Granada is bounded North with *Castella Aurea*; West with *Mare-del-Zur*; East with *Venezuela*; and South with *Terra Incognita*. Its length is 390 Miles, and as much in breadth. It doth consist of these two parts, *Viz. Granada*, specially so called, and *Popayan*, both which hath a temperate Air, brave Woods, well stored with *Catile*, and *Fowls* both wild and tame, plenty of *Emeralds* and *Guacum*: the People tall and strong; the Women handsome and better drest than their Neighbours: The chief Towns are S. *Toy d' Bagota* and *Popayan*.

Peru is bounded East with the *Andes*; West with *Mare-del Zur*; North with *Popayan*; and South with *Chile*. It is 2100 Miles in length, and its breadth is 300 Miles: it is a Mountainous Country: And here 'tis to be noted that in the Plains it never raineth; and that on the Hills it continually raineth from *September* to *April*, and then breaks up. In the Hilly Countreys the *Summer* begins in *April*, and endeth

in

in *September*. In the Plains the *Summer* beginneth in *October* and endeth in *April*. So that a man may travel from Summer to Winter both in one Day; be frozen in the Morning when he setteth out, and scorched with heat before the dawning of the Day. It is not very plentifull of Corn nor Fruits, but they have a kind of Sheep which they call *Pacos* as bigg as an *Ass*, profitable both for fleece and burthen, but in tast as pleasant as our *Mutton*: So subtile that if it be overladen it will not for blows move a foot till the burthen be lessened, and it is a very hardy Creature. Here is a Figg-tree, the North part of which looketh towards the Mountains, and yieldeth its Fruit in Summer only, and the Part facing the Sea in Winter only. They have another Plant, that if put into the hands of the Sick and the Patient looks merry, they will recover; but if sad, die. It yieldeth also Multitudes of Rarities more. It's chief Commodities are *Gold*, *Silver*, *Tobacco*, *Sarsaparilla* and *Balsamum d' Peru*, and many other rich *Drugs*. The Natives are almost now rooted out of the Country. They are fierce and *Barbarous*. Now it contains these *Provinces*: viz. *Quito*, *Los Quinxos*, *Lima*, *Cusco*, *Charcos* and *Collao*. §. 2. *America*.

Chile is bounded North with *Deserta Alacama*; West with *Mare del Zuz*; South with the Straits of *Magellan*; and East with *Rio de la Plata*. Its length is 1500 miles, and breadth uncertain. The Soil hereof in the Mid-land is mountainous and unfruitfull; towards the Sea-side level and fertile; with products of *Maize* and *Wheat*, plenty of *Gold* and *Silver*, *Cattle*

§. 2. and *Wine*. The Natives are very tall and warlike, some of them affirmed to be eleven foot
America. high; their Garments of the Skins of Beasts; they are of a white Complexion; their Armes *Bows* and *Arrows*. It is divided into *Chile* (especially so called) and *Magellanica*. Here Sir *Walter Rawleigh* planted two *Collonies*, who for want of timely Succors were either starved at home, or eaten by the *Salvages*, as they ranged the Countrey for food.

Paraguay is bounded South with *Magellanica*; East with the main *Atlantick*; North with *Brazila*; and West with *Terra Incognita*. It is said to be of a fruitfull Soyl, well stored with *Sugar-Canes*, *Fraught* with Mines of *Gold*, *Brass*, and *Iron*: great plenty of *Amathyses*, and *Monkeys*, *Lyons* and *Tigers*, the People are as the other *Salvages*, and it contains these Provinces, *viz*. *Rio de la Plata*, *Tucaman* and *La Crux de Sierra*, and it's chief Towns are *Puenas Agrees*, and *Chividad*.

Brazila is bounded East with *Mare del Noort*; West with *Terra Incognita*; North with *Guiana*; and South with *Paraguay*. Its said to be 1500 Miles long and 500 broad. The Countrey is full of Mountains, Rivers and Forests, the Air sound and healthfull; the Soyl is indifferent fruitfull: Its chief Commodities are *Sugar* and *Brazele-wood*. There is a Plant called *Copiba* which yields *Balsam*, soveraign for Poyson. An Herb called *Viva*, which if touched will shut up and not open till the Toucher is out of sight. A Creature which hath the Head of an *Ape*, the Foot of a *Lyon*, and the rest of a *Man*. The *Ox-Fish* with *Arms*, *Fingers* and *Duggs*, the rest

rest as a *Cow*. So that it may be said of *Brasila*——*Semper aliquid apportat novi*. §. 2.

The people are witty as appears by their sayings to the Christians (holding up a Wedge of Gold) say'd they, *Behold your God oh ye Christians!* on their Festival-days they go Naked, both Men and Women; and are able Swimmers, staying under water an hour and half: the Women are delivered without great pain: some of the Natives are all over Hairy, like Beasts: it containeth not Provinces, but these Captain-Ships: *viz. Vincent*, *Rio de Juneiro*, *Holy Ghost*, *Porto-Seguro*, *Des Ilheos*, *Todos los Santos*, *Fernambuck*, *Tamaraca*, *Paraiba*, *Rio Grande*, *Saiara*, *Maragnon*, and *Para*. Its chief Cities are, *Meranhan*, *Tamaracai*, and *Olinda*, and the great River *Zoyal*. America.

Guiana is bounded East with the *Atlantick*; West with *Mount-Peru*; North with the *Flood Orenoque*; and South with the *Amazones*. The Air here is indifferently good: near the Sea it is plain and level, up in the Countrey Mountainous; here the Trees keep their leaves all the year, with their fruit always ripe, and growing. The Inhabitants are under no settled Government: they punish only *Murder*, *Theft*, and *Adultery*; their Wives are their Slaves, and they may have as many as they please; they are without *Religion* or Notion of a *Deity*. It doth contain these Provinces: *viz. Rio de las Amazones*, *Wiapoce*, *Orenoque*, and the Isles of *Guiana*. Its Comodities are *Sugar*, and *Cotton*: in it are plenty of *Beast*, *Fish*, and *Fowles*; they are Swarthy in Complection, and great *Idolaters*; as for Cities it hath none of note.

§. 2. *America.* *Paria* is bounded on the East with *Guiana*; West with the Bay of *Venezuela*; North with the *Atlantick Ocean*; and South with *Terra Incognita*: and contains these Provinces: *Viz.* *Cumana*, *Venezuela*, S. *Margarita*, *Cutagana*, and its Isles. All which are not very fruitfull; it is well stored with Pearls; the People paint their Teeth and Bodies with Colour: The Women are trained up to ride, run, leap and swim: and also to Till the Land. In it are these most noted Cities: *Viz.* St. *Jago*, St. *Michael de Nevery*, and *Mahanao*.

As for the Descriptions of the *American Isles* I must beg the favour to omit: I shall therefore only name them having been so very large already; and they are these: *Viz.* *Los. Ladrones*, *Fernandes*, the *Caribes*; as *Granada*, S. *Vincent*, *Barbados*, *Matinino*, *Dominica*, *Desrada*; *Guadalupe*, *Antego*, S. *Christopher*, *Nieves*, *Sancta Crux*, and some lesser Isles belonging to them: As also *Portorico*, *Monico Hispaniola*, *Cuba* and *Jamaica*. Thus I have finished the Description of the known Earth.

Now the Names of the Seas are these: *Viz.* the *Ocean Sea*, *Narrow Sea*, *Mediterranean Sea*, *Mare Major*, *Mare Pacificum*, *Mare Caspium*, the *East-Indian Sea*, *Persian Sea*, *Red Sea*, and *Mare-del-Zuz*, which are all the Principal Seas.

Thus through the Blessing of God I have given you a brief, tho' true Description of all the known *Earth* and *Seas*, and have thus finished my *Geographical Descriptions* of the *Division* of the *Earthly Globe*.

Oh

§. 2.

The Author on the Difficulties in the Collection of his ΜΙΚΡΟΚΟΣΜΟ'Σ, *or little Description of the great World.*

Oh thou Urania! *Thou that hast now brought*
Our Ship *to* Harbour *sound, and richly fraught.*
Tho' Æolus *his blustring Gales did send,*
And foaming Billows high, the Skies did rend:
Tho' Blustring storms, and Thunder loud did roar,
And darkness Grim, opprest our Souls all 'ore;
So that we could not view the Stars, *nor* Sky,
Nor Sun, *nor* Moon, *nay* Earth, *could not espy.*
Yet by thy Art, such safety we did find,
Safely to pass both raging Seas, and Wind.
And at the last a Harbour, safe did gain:
Rejecting fears; we quite cast off our pain.
When Seas are calm, and Winds more serene be,
Then we again will put our Ship to Sea;
That when refresht we farther may descry,
And search into this Noble Treasury.

Δόξα Θεῷ.

SECT. III.

§. 3.

Of Geographical Propositions.

PROP. I.

How to find the Distance of any two Cities or Places, which differ onely in Latitude.

IN this Proposition there are two Varieties which are these.

1. If both the Places lie under one and the same *Meridian*, and on one and the same side the *Equinoctial*, either on the *North* or *South* side thereof; then substract the lesser *Latitude* from the greater, and convert their difference into *Miles* (by allowing 60 *Miles* for a *Degree*) so have you the distance of the two Places propounded.

2. But if the two Places lie under one and the same *Meridian*, but the one on the South side of the *Equinoctial*, and the other on the North side, then add both their *Latitudes* together their Sum is their Distance.

PROP. II.

To find the Distance of any two Places which differ only in Longitude.

There are also in this Proposition two Varieties.

1. The two Places may both lie under the *Equinoctial*, and so have no *Latitude*: and if so, substract

ſubſtract the leſſer *Longitude* out of the greater, and convert the remainder into *Miles*; ſo have you the diſtance of any two Places ſo poſuited. §. 3.

2. But if the two Places differ only in *Longitude*, and lieth not under the *Equinoctial*, but under ſome other *Intermediate Parallel of Latitude*, between the *Equinoctial*, and one of the *Poles*: Then to find their diſtance, this is the *Analogy* or *Proportion*.

As Radius or S. 90°,
To Sc. *of the Latitude :*
So is S *of* ½ X. *of Longitude*,
To S. of ½ *their diſtance*, which being doubled, and converted into Miles, giveth the required diſtance.

PROP. III

To find the Diſtance of any two Places, which differ both in Latitude, and in Longitude.

In this Propoſition three Varieties do preſent themſelves to our View.

1. One of the Places may lie under the *Equinoctial* and have no *Latitude*, and the other under ſome *Parallel of Latitude* between the *Equinoctial* and one of the *Poles*. In ſuch caſe obſerve this *Analogy* or *Proportion*.

As Radius or S. *of* 90°,
To Sc. *of their* X. *of Longitude :*
So is Sc. *of their Latitude*,
To Sc. *of their Diſtance required.*

§. 3. 2. But if both the Places proposed shall be without the *Equinoctial*, but on the one side either both towards the *North*, or both towards the *South*, then their Distance may be found, by this *Analogy* or *Proportion.*

As Radius or S. 90° 00′,
To Sc. *of their* X. *of Longitude:*
So is Tc. *of the greater Latitude,*
To the T. *of a fourth Arch*, which substracted from the *Complement* of the lesser *Latitude*, the remainder must be the *fifth Arch* ; Then say,
As Sc. *of the fourth Arch,*
To Sc. *of the fifth Arch :*
So is S. *of the greater Latitudes,*
To Sc. *of the Distance of the two proposed Places,*

3. The two Places propounded may be so situated, that one of them may lie on the *North*, and the other on the *South* side the *Equinoctial* : the Distance of Places so situated may be obtained, by this *Analogy* or *Proportion.*

As Radius or S. 90°,
To Sc. *of* X. *of Longitude:*
So is Tc. *of the greater Latitude,*
To T. *of a fourth Arch*, which being substracted out of the Summ of the other *Latitude*, and the *Radius* or 90° *Deg.* the remainder is a *fifth Arch* ; Then say,
As Sc. *of the fourth Arch,*
To Sc. *of the fifth Arch :*
So is S. *of the Latitude first taken,*
To Sc. *of the Distance required.*

These

These are all the Varieties of the Positions of Places on the *Terrestrial Globe*: For if the Distance of any two Places be required, they must fall under one or other of these Varieties, and may be obtained by one or other of the *Proportions*, mentioned in the three aforegoing Propositions. §. 3.

Also if you know the *Latitude* and *Longitude* of any two fixed *Stars*, or their *Right Ascension* and *Declination*, then by these Rules their Distance may be found, which is of good use to *Astronomy*. It may also be applyed to *Circular Sailing*; of all other ways the most perfect: which is treated of in its due Place.

CHAP.

CHAP. VIII.

Of NAVIGATION.

NAVIGATION *So called from* Navis *a Ship, is an Art Mathematical, which sheweth how by the shortest good Way, by the aptest Direction, and in the shortest Time, to conduct a Ship from any one place unto any other place assigned: it hath been highly esteemed by the Ancients; it is the Glory, Beauty, Bullwark, Wall and Wealth of* Britain, *and the Bridge that joyns it to the Universe. Navigation is commonly divided into three sorts of Sailing:* viz. *Plain sailing, Mercator's sailing, and Circular sailing: Of all which three Parts I shall treat in their Order.*

SECT.

SECT. I. §. 1.

Of Plain sailing, or sailing by the Plain Chart.

PLain Sailing, or sailing by the *Plain Chart*, is the most plainest way, and the Foundation of all the Rest: and although the Ground and Projection of the *Plain Chart* is erroneous, yet seeing it is more facile to the Learner, and may serve indifferently near the *Equinoctial*, because there the *Degrees* of *Longitude*, as well as the *Degrees* of *Latitude*, are Equal: Each Degree being divided into 60 *Minutes*, or *Milles*, though they are somewhat more than *English Miles*, Each *Minute* or *Mile* containing about 6000 Feet.

PROP. I.

The Doctrine of Rightlined Triangles, both Right, and Oblique-Angled, applied to Propositions of Plain Sailing.

The Rumb, and Distance sailed thereon being given, to find the Difference of Latitude, and the Departure from the Meridian.

Admit a Ship sails N. W. by N. 372′ or Miles, or 124 Leagues, I demand her *Difference* of *Latitude* and departure from the *Meridian*?

In

§. 1. In the *Triangle* ABC, the *Hypothenuse* AC
Fig. 44. representeth the distance sailed, or *Rumb-line*, BC the departure from the *Meridian*, and AB the difference of *Latitude*.

1. To find which say,
As Radius or S. 90°,
To Log. distance sailed 372′.
So is Sc. *V.* A of the Course 56° 15′,
To Log. cr. AB $309\frac{3}{10}$ Minutes, which being divided by 60′ giveth 5°. 9′. 18″ for the *Difference* of *Latitude*.

Fig. 44. 2. To find the Departure from the *Meridian* say,
As Radius or S. 90°,
To Log. Rumb-line AC 372′.
So is S. of *V.* of the Course A 33° 45′,
To Log. cr. BC $206\frac{6}{10}$ Minutes, the departure from the *Meridian*, which divided by 60 giveth 3°. 26′. 36″ for the difference of *Longitude*.

☞ Note that by this Proposition you may keep an Account how much you have sailed either *East* or *West*, *North* or *South*.

PROP. II.

By the Rumb and Difference of Latitude given, To find the Distance, and the Departure from the Meridian.

Fig. 44. Admit a Ship sail N. W. by W. untill her difference of *Latitude* be $309\frac{3}{10}$ Minutes, I demand her distance sailed, and her departure from the *Meridian*?

1. To

1. To find the distance, say, §. 1.
As Sc. of *V.* of the Course A 56° 15′,
To Log. cr. AB the X. of Lat. $309\frac{3}{10}$ Minutes.
So is the Radius or S. 90°,
To Log. AC 372′ the distance sailed.

2. For the *Departure*, say, *Fig.* 44.
As Sc. of A *V.* of the Course 56° 15′,
To Log. cr. AB. X of *Lat.* $309\frac{3}{10}$ Minutes.
So is S. of *V.* of the Course A 33° 45′,
To Log. cr. AB $206\frac{6}{10}$ Minutes, the *Departure* required.

☞ By the help of this Proposition, when your *Latitude* by Observation doth not agree with your dead reckoning, (kept by the former Proposition.) Then according to this Rule, you may make your way sail'd agree with your *Observed Latitude*, and so correct your Account or dead Reckoning.

PROP. III.

By knowing the Distance of the Meridians of two Places, and their Difference of Latitude, to find the Rumb, and Distance.

Admit A, to represent the *Lizard*, AB the *Parallel* thereof, C. St. *Mary's Islands*, being one of the *Azores*, and CB the *Meridian* thereof.

In the *Triangle* ABC, there is given the side AB 816 Minutes, the Distance of the *Lizard*, from the *Meridian* of St. *Marys*, and the side CB their difference of Latitude 768 Minutes, I *Fig.* 45. demand the *Rumb*: i. e. the Angle at C, and the Distance of the *Lizard* from St. *Marys*?

1. For

§. 1. 1. For the *Rumb* or Angle at C, ſay,

As Log. cr. CB 768′,
To Radius or S. 90°.
So is Log. cr. AB 816′,
To T. *of the Rumb*, or Angle at C 46° 44′, and is from the *Lizard* unto St. *Marys* to the fourth *Rumb* of the *Meridian*, and 1° 44′ more, *Viz.* S. W. and 1° 44′. Weſterly, or from St. *Marys*, to the *Lizard*, N. E. and 1° 44′ Eaſterly: and thus it ſhall be by the *Plain Chart*.

2. For their *Diſtance* AC, ſay,

As S. *Rumb.* or *V.* at C. 46° 44′,
To Log. cr. AB 816′ Minutes.
So is Radius or S. 90°,
Fig. 45. *To Log. Hypoth.* AC 1120′ $\frac{5}{10}$ which is the Diſtance of the *Lizard*, unto St. *Marys Iſland*, and ſuch ſhould be the diſtance by the *Plain Chart*.

PROP. IV.

Admit two Ships to ſet ſail from one Port, one Ship ſails W. S. W. 40′, the other W. by N. ſo far untill ſhe finds the firſt Ship to bear from her S. E. by E. I demand the ſecond Ships diſtance from the Port, and their Diſtance aſunder?

In the *Triangle* ADE, let A repreſent the *Port*, AD the W. S. W. courſe, and AE the
Fig. 46. Courſe W. by *North*.

1. To find the ſecond Ships diſtance from the *Port*, ſay,

As S. of *V.* at E. 22° 30′,
To Log. cr. AD 40′ Minutes.

So

So is S. of *V*. at D 123° 45′, §. 1.

To Log. cr. AE 86,$\frac{98}{100}$ Minutes, which is the distance required. *Fig*. 46.

2. To find the two Ships their distance Asunder, say,

As S. of *V*. at E 22° 30′,
To Log. cr. AD 40 Minutes.
So is S. of *V*. at A 33° 45′,
To Log. cr. DE 58,$\frac{12}{100}$ Minutes, which is the Distance required.

PROP. V.

Two Ships sets sail from two Ports, which lie N. and South of each other, the one sails from the Northermost Port 72,$\frac{29}{100}$′, and then meets the other Ship, which came from the Southermost Port, on a N. W. Course, and had sailed from thence 56,$\frac{80}{100}$′ I demand the Rumb on which the first ship made her way, and also the Distance between the two Ports?

In the *Triangle* ADE, let A be the Southermost Port, AD the Course and way of the second Ship N W. 56,$\frac{80}{100}$′, let E be the Northermost Port, ED the Course and Way of the other Ship 72,$\frac{29}{100}$′, and D the Place where they both meet. *Fig*. 47.

1. To find the *Rumb* on which the first Ship sailed, say,

As Log. cr. DE 72,$\frac{29}{100}$ Minutes,
To S. of *V*. at A 45° 00′.
So is Log. cr. DA 56,$\frac{80}{100}$ Minutes,

To

§. 1. *To* S. of *V*. at E 33° 45′, which sheweth the Course of the first Ship to be S. W. by South.

Fig. 47. 2. To find the Distance between the two Ports A and E, say,

As S. of *V*. at A 45° 00′,
To Log. cr. DE $72\frac{29}{100}$ Minutes.
So is S. of *V*. at D 101° 15′,
To Log. cr. EA 100′, which is the required Distance.

PROP. VI.

Admit a Ship coming off the Main Ocean and I had sight of a Promontory or Cape, by which it is my desire to sail, I find it to bear from me S. S. E. and distant by Estimation 33′ or Miles: But keeping still on my Course S. untill the Evening, having sailed 36′ or Miles, I would then know how the Cape bears, and its distance from the Ship?

In the *Triangle* ADE, admit that at A, I do observe the *Cape* D, to bear from me S. S. E. 33′, and having sail'd from A, to E 36′ South, I desire to know its Distance, and bearing. In
Fig. 48. the *Triangle*, there is therefore given, AD 33′, AE 36′, and the Angle at A 22° 30′.

1. To find the Angle at E, say,

As Z. cr^s. AE, and AD 69′,
To X. cr^s. AD, and AE 03′.
So is T. $\frac{1}{2}$ *VV* unknown D and E 78° 45′,
To the T. of 12° 20′, which taken from 78° 45′, leaves the Angle at E 66° 25′; so that the

Cape

Cape D then bears from me E. N. E. and 01° 05′ Northerly. §. 1.

2. To find the Distance of the *Cape* ED from the Ship, say,

As S.*V*. at E 66° 25′,
To Log. cr. AD 33′.
So is S.*V*. at A 22° 30′,
To Log. cr. ED $13\frac{78}{100}$ Miles distant, so that the *Cape* is then distant from the Ship $13\frac{78}{100}$ Miles.

PROP. VII.

Two Ports both lying in one Latitude, distant 64′ or Miles, the Westermost of those Ports lieth opposite to an Island, more Northerly distant therefrom 47′ or Miles, which Island is also distant from the Eastermost Port, 34′ or Miles, I demand the Course from the Westermost Port to that Island?

In the *Triangle* ADE, let A be the *Westermost Port*, and E, the *Eastermost Port*, distant Asunder 64′; and let D be the *Island*, distant from A 47′, and from E 34′: Then is the Angle at A required, which is the *Course* or *Rumb*, from the *Westermost Port*, unto the *Island*: To find which, say, Fig. 49.

As Log. cr. AE 64′,
To Log. Z. cr^s. AD, and ED 81′.
So is Log. X. cr^s. AD, and ED 13′,
To Log. of a certain line AO $16\frac{45}{1000}$.
Which added to AE 64, is $80\frac{454}{1000}$,
The $\frac{1}{2}$ *whereof* is AB, $40\frac{227}{1000}$
Then again say,
As Log. cr. AD 47′,

To Radius or S 90°.
So is Log. AB $40\frac{227}{1000}$,
To Sc. *V.* at A, 58° 51′, that is N.E. by E. 2° 36′ Easterly, which is the Course from the *Westermost Port* A, unto the *Island* D.

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§. 2. ## SECT. II.

Of sailing by the true Sea Chart, commonly called MERCATOR'S *Chart.*

THE *true Sea Chart*, commonly called *MERCATOR'S Chart* *, performs the same Conclusions as the *Plain Chart*, and almost as speedily, but far more exactly: Because all Places may be laid down hereon, with the same truth as on the *Globe* it self: both to their *Latitudes*, *Longitudes*, *Bearing* and *Distance* from each other.

* *But is indeed the Invention of our Learned Countryman* Mr. Edw. Wright, *although this Stranger hath almost got the Name and Praise thereof.*

And here it will be necessary to have a Table of *Meridional Ports*, which I have extracted out of Mr. *Wright's Tables*, to every tenth Minute of Latitude; accounting it in single Miles, or Minutes of the *Equinoctial*, and have hereunto annexed the said Table.

A Table

6: 2:

A Table of Meridional Miles

The Deg. of Lat.	*The Minutes of each Degree.* 0	10	20	30	40	50	The Difference.
	The Meridional Miles.						
0	0	10	20	30	40	50	10
1	60	70	80	90	100	110	10
2	120	130	140	150	160	170	10
3	180	190	200	210	220	230	10
4	240	250	260	270	280	290	10
5	300	310	320	330	340	350	10
6	360	370	380	390	400	410	10
7	421	431	441	451	461	471	10
8	481	491	501	511	521	532	10
9	542	552	562	572	582	592	10
10	603	613	623	633	643	653	10
11	664	674	684	694	704	715	10
12	725	735	745	755	766	776	10
13	786	797	807	817	827	838	10
14	848	858	869	879	889	900	10
15	910	920	931	941	951	962	10
16	972	983	993	1004	1014	1024	10
17	1035	1045	1056	1066	1077	1087	10
18	1098	1108	1119	1129	1140	1150	10
19	1161	1172	1182	1193	1203	1214	10
20	1225	1235	1246	1257	1267	1278	11
21	1289	1299	1310	1321	1332	1342	11
22	1353	1364	1375	1386	1396	1407	11
23	1418	1429	1440	1451	1462	1473	11
24	1484	1499	1505	1516	1527	1538	11
25	1549	1561	1572	1583	1594	1605	11
26	1616	1627	1638	1649	1661	1672	11
27	1683	1694	1705	1717	1728	1738	11
28	1751	1761	1773	1785	1796	1808	11
29	1819	1830	1842	1853	1865	1867	11

§. 2.

The Deg. of Lat.	0	10	20	30	40	50	The Difference
	The Minutes of each Degree						
	The Meridional Miles.						
30	1888	1899	1911	1923	1934	1946	12
31	1958	1969	1981	1993	2004	2016	12
32	2028	2040	2052	2063	2075	2087	12
33	2099	2111	2123	2135	2147	2159	12
34	2171	2183	2195	2207	2219	2231	12
35	2244	2256	2268	2281	2293	2305	12
36	2318	2330	2342	2355	2367	2380	12
37	2392	2405	2417	2430	2442	2455	12
38	2468	2481	2493	2506	2519	2532	13
39	2544	2557	2570	2583	2596	2609	13
40	2622	2635	2648	2662	2675	2668	13
41	2701	2714	2718	2741	2754	2768	13
42	2781	2795	2808	2822	2835	2849	13
43	2863	2876	2890	2904	2918	2931	14
44	2945	2959	2973	2987	3001	3015	14
45	3030	3044	3050	3072	3086	3101	14
46	3115	3130	3144	3159	3173	3188	14
47	3202	3217	3232	3247	3261	3276	15
48	3291	3306	3321	3336	3351	3366	15
49	3382	3397	3412	3428	3443	3459	15
50	3474	3490	3505	3521	3537	3553	16
51	3568	3584	3600	3616	3632	3649	16
52	3665	3681	3697	3714	3730	3747	16
53	3763	3780	3797	3814	3830	3847	17
54	3864	3881	3899	3616	3933	3950	17
55	3968	3985	4003	4020	4038	4056	18
56	4074	4092	4110	4128	4146	4164	19
57	4182	4201	4219	4238	4257	4275	19
58	4294	4313	4331	4351	4370	4390	20
59	4409	4428	4448	4468	4487	4507	20

§. 2.

A Table of Meridional Miles.

The Deg. of Lat.	The Minutes of each Degree. 0	10	20	30	40	50	The Difference.
	The Meridional Miles.						
60	4527	4547	4567	4588	4608	4629	20
61	4643	4670	4691	4711	4733	4754	21
62	4775	4796	4818	4839	4861	4883	22
63	4905	4927	4949	4972	4994	5017	23
64	5039	5062	5085	5018	5132	5155	23
65	5179	5203	5226	5250	5275	5299	24
66	5324	5348	5373	5390	5423	5449	25
67	5474	5500	5520	5552	5678	5704	26
68	5631	5658	5685	5712	5739	5767	27
69	5795	5823	6021	5879	5908	5937	28
70	5966	5996	6125	6035	6085	6115	30
71	6146	6177	6208	6239	6271	6303	31
72	6335	6368	6401	6431	6468	6501	33
73	6535	6570	6605	6640	6675	6718	35
74	6747	6783	6820	6857	6895	6933	37
75	6972	7010	7050	7089	7130	7170	40
76	7211	7253	7295	7338	7381	7424	43
77	7469	7513	7559	7605	7651	7698	46
78	7746	7795	7844	7894	7944	7996	50
79	8048	8100	8154	8209	8264	8320	55
80	8377	8435	8495	8555	8616	8678	60
81	8742	8806	8872	8939	9007	9077	68
82	9148	9221	9295	9371	9449	9528	77
83	9609	9692	9778	9865	9954	10046	88
84	10141	10238	10333	10441	10547	10656	105
85	10770	10887	11007	11133	11263	11398	128
86	11539	11686	11839	11999	12168	12344	165
87	12521	12718	12927	13150	13388	13644	230
88	13920	14221	14550	14914	15321	15783	386
89	16318	16950	17726	18729	20152	22623	

§. 2. *The Use of the Table is demonstrated by the several Examples following, after this Manner.*

PROP. I.

To find by the Table, what Meridional parts are contained in any Difference of Latitude.

In this Propoſition three Varieties preſent themſelves unto our View.

1. When one Place is under the *Equinoctial*, the other having *North*, or *South Latitude*, his *Meridional parts* correſponding, is to be eſteemed for the *Meridional Difference* of *Latitude.*

2. When both Places are towards one of the *Poles*, then the *Meridional parts* of the *leſſer*, taken from the *Meridional parts* of the *greater Latitude*, the remainder is the *Meridional difference* required.

3. When one Place hath *North*, and the other *South Latitude*, their correſponding *Meridional parts* added together gives the *Meridional difference* of *Latitude* ſought: thus having ſound them out they may thus be applyed.

PROP.

§. 2.

PROP. II.

By knowing the Latitudes, and the difference of Longitude of any two Places, to find the Rumb, and Distance.

Admit there be a *Port* in the *Latitude* of 50° 00′ *North*, and another in the *Latitude* of 13° 12′ North, and their *Difference* of *Longitude* is 52° 57′ West, I demand the *Rumb* and *Distance?*

In the *Triangle* A b c, let A b represent the proper difference of *Latitude*, b c the *Departure*, Ac the distance sailed, A the Angle of the *Course*, c the *Complement* of the *Course*. Fig. 50.

In the *Triangle* ABC, AB is the *Meridional difference* of *Latitude*, BC the *Difference* of *Longitude*, A the Angle of the *Rumb*, C the *Compl.* of the Angle of the *Rumb*: These things being understood the work evidently appears to be the same as in *Rightangled Plain Triangles.*

There is then required first the *Difference* of *Latitude*, and this falls under the second Variety.

One Port lieth in the Lat.	50°	00′	N.	3475
The other lieth, in	13	12	N.	0799
The Merid. diff. of Latit.				2676

M. Parts

1. To find the *Rumb* or *Course* say,
As Merid. X. *Lat.* 2676′,
To Radius or S. 90°.

§. 2. *So is* X. *of Longitude* 3177′,
To T. *of the Rumb* 49°. 53′, the *Course* therefore is S. W. ½ W, *&c.*

Fig. 50. 2. To find the *Distance*,

Lat.	50°	00′
Lat.	13	12
Proper. diff. of Lat.	36	48 *which is* 2208′.

As Sc. *Course* 40° 07′,
To proper X. *of Lat.* 2208′.
So is Radius or S. 90°,
To the Distance 3426 *Minutes* as required.

PROP. III.

By knowing the Latitudes, and distance of two Places, to find the Rumb, and Difference of Longitude.

1. To find the *Rumb* or *Course* say,
As the Distance sailed,
To Radius or S. 90°.
So is the X. *of Latitude,*
To Sc. *of the Rumb* required.

2. To find the *Difference of Longitude* say,
As Radius or S. 90°,
To the X. *of Latitude in Merid. Parts.*
So is T. *of the Rumb,*
To the X. *of Longitude* required.

PROP.

§. 2.

PROP. IV.

By knowing the Latitudes, and Rumb of two Places, to find their Distance, and Difference of Longitude.

1. To find the *Distance* ſay,
As Sc *of the Rumb,*
To the X *of Latitude.*
So is Radius or S. 90°,
To the Distance required.

2. To find the *Difference of Longitude* ſay,
As Radius or S. 90°,
To the X. *of Latitude in M. Parts.*
So is T. of the Rumb,
To the X. *of Longitude* required.

PROP. V.

By knowing the Rumb, Difference of Longitude, and one Latitude, to find the other Latitude, and the Distance.

1. To find the other *Latitude* ſay,
As T. *of the Rumb,*
To the X *of Longitude in parts.*
So is Radius or S. 90°,
To the Merid. X. *of Latitude* required.

2. To find the *Distance* ſay,
As Sc. *of the Rumb,*
To the X. *of Latitude.*
So is Radius or S. 90°,
To the required Distance.

PROP.

§. 2.

PROP. VI.

By knowing the Distance, one Latitude, and Rumb, to find the other Latitude, and Difference of Longitude.

1. To find the *Difference* of *Latitude* say,
As Radius or S. 90°,
To the Distance.
So is Sc. *of the Rumb,*
To the X. *of Latitude* required.

2. To find the *Difference* of *Longitude* say,
As Radius or S. 90°,
To the Merid. X. *of Latitude.*
So is T. *of the Rumb,*
To the X. *of the Longitude* required.

SECT. III.

§. 3. *Of Circular Sailing, or Sailing by the Arch of a Great Circle.*

THIS is of all other the most exact way of sailing, and above all other most perfect, shewing the nearest way, and distance between any two *Places:* and although it is hardly possible to keep close unto the *Arch* of a *great Circle*, yet it is of great advantage to keep conveniently near it, especially in an *East* or *West* Course:

Course: In the former Propoſitions of ſailing, we uſed *Meridians*, *Parallels* and *Rumbs*, as the *Sides* of every *Triangle*, whether by the *Plain* or *Mercator's Chart*: but in *Circular ſailing* the *Rumbs* are not uſed ſo, becauſe they are *Heliſpherical-lines*, and not *Circles*; nor the *Parallels*, becauſe they are not *great Circles*: Whereas the ſides comprehending every *Spherical Triangle* are *Arches* of *great Circles*: Therefore here we uſe *Arches* of the *Meridians*, of the *Equinoctial*, and of other *great Circles* deſcribed, or ſo imagined to be deſcribed, from one Place unto another, on the *Spherical Superficies* of the *Earth* and *Sea*. §. 3.

Therefore here ariſeth two things obſervable: and,

1. If the two places lie under the *Equinoctial*, then is their Poſition *Eaſt* and *Weſt*, and their diſtance is their *Difference* of *Longitude*, converted into *Miles*: or,

2. If the two Places propoſed be in one and the ſame *Meridian*, then is their *Poſition North* and *South*, and their *Diſtance* is their *Difference* of *Latitude* converted into *Miles*.

And thus far doth *Circular ſailing* agree with the former; their difference will evidently appear by theſe following Propoſitions.

PROP.

§. 3.

PROP. I.

Two Places, the one under the Equinoctial, the other in any Latitude given; also their difference of Longitude given, to find.

1. *Their Distance in the Arch of a great Circle.*
2. *The direct Position of the first place from the second.*
3. *And of the second Place from the first.*

Here we call the *Angles* which the *Arch* makes with the *Meridians* of the places propounded, the *Angles* of the *Direct Positions* of those places one from the other: because the *Arch* of a great *Circle* drawn between two places is the nearest distance; and the most direct way of the one, to the other Place. Now I shall not here demonstrate it by *Schemes*, as I have done in the other two Sections, but shall only lay down the proportions, whereby the required parts may be found; and so leave the ingenious Seamen to practice it with *Schemes* at his leasure: and,

1. To find the nearest distance from Place to place, in the *Arch* of a *Great Circle*: Say according to *the* 10 *Case* of *Rectangled Spherical Triangles.*

As the Radius,
To Sc. of X. of *Longitude.*
So is Sc. of X. of *Latitude*;
To Sc. of the *Distance* in the *Arch* required.

2. For the *Direct Position*, say by the 11 *Case* thus,

As the Radius,
To S. of X. of *Latitude*,

So

So is Tc. of X. of *Longitude*, §. 3.
To Tc. of *V.* of *Position* required.

3. For the *Direct Position* of the second Place from the first, say by the 11 *Case* thus,
As the Radius,
To S. of the X of *Longitude*.
So is Tc. of X. of *Latitude*,
To Tc. of *V.* of *Position* required.

PROP. II.

Two Places proposed, the one lying under the Equinoctial, the other in any Latitude given; with their distance in a great Circle of the same Places being also known, to find.

1. *Their Difference of Longitude.*
2. *The direct Position from the first to the second Place.*
3. *And from the second to the first Place.*

1. For their *Difference* of *Longitude*, say by *Case* 12,
As Sc. of the *Latitude*,
To Radius.
So is Sc. of their *Distance* in the *Arch*,
To Sc. of their *Difference* of *Longitude* required.

2. Now to find the *Direct Position* from the first place to the second, say by the 13 *Case*; and thirdly, for the *Direct Position* from the second place to the first, say by the 14 *Case* of *Rectangulars*.

PROP.

§. 3.

PROP. III.

Two Places lying in one Latitude given, their difference of Longitude being also known, to find.

1. *The nearest distance of those two Places.*
2. *The direct Position of one Place from the other.*

The Resolution of this Proposition depends on the 9 *Case* of *Oblique Spherical Triangles*: by supposing the *Oblique Triangle*, to be transfigured or converted into two *Rectangulars*, by a supposed *Perpendicular*: and then,

1. To find the nearest distance in the *Arch*, say by the 8 *Case* of *Rectangulars.*

As the Radius,
To Sc. *of the Latitude.*
So is S. *of half* X. *of Longitude,*
To S. of half the required distance, which doubled giveth the distance of the two places in the *Arches*, as sought.

2. For the *Direct Position*, say by the 9 *Case.*

As the Radius,
To S. *of the Latitude.*
So is T. of half X. of *Longitude,*
To Tc. of *V.* of *Position* required.

PROP.

PROP. IV.

Two Places lying both in one Latitude given, and the nearest distance being also known, to find.

1. *Their Difference of Longitude.*
2. *The direct Position of the one Place from the other.*

The Resolution of this Proposition falls under the 11 *Case* of *Oblique Spherical Triangles* : for here you have the three sides of the *Triangle* given, *viz.* the *Arch of Distance*, and the other two sides (are both equal) being the *Complements* of the places *Latitude* : and here seeing the two sides are equal, therefore the two Angles of *Position* are also equal : now there is required the three Angles,

1. To find their *Difference of Longitude*, add the double of the *Complement* of *Latitude* to the *Arch of Distance* ; then from half this Sum, deduct the *Arch of Distance*, and then proceed in all points as you see in *Case* the 11*th*. So shall their *Difference of Longitude* be obtained.

2. To find their *direct Position* : first,
First to the double *Complement* of *Latitude*, add the *Arch of Distance*, then from half that *agragate*, deduct the *Complement of Latitude*, and then work as before, so shall the *direct Position* be attained.

PROP.

4..3.

PROP. VI.

Two Places proposed lying in one Latitude, and the distance of those Places in their Parallel given, to find.

1. *Their Difference of Longitude,*
2. *Their distance in the Arch of a great Circle,*
3. *The direct Position of the one from the other.*

Now you must understand, that as the *Semidiamiter* of a *Parallel*, is in proportion to the *Semidiamiter* of the *Equinoctial*: so is any number of *Miles* in that *Parallel*, to the *Minutes* of *Longitude* answering to those *Miles*: so that if we suppose the *Semidiameter* of the *Equinoctial* to be *Radius*, then the *Semidiameter* of any *Parallel* is the *Sine* of that *Parallel's* distance from the *Pole*, that is the Sc. of the *Latitude* of that *Parallel*: Therefore,

1. To find the *Diff.* of *Longitude* say,

As Sc. *of the Latitude,*
To the Radius,
So is the Distance in that Parallel,
To the Diff. of Longitude required.

2. Now the *Difference of Latitude* being obtained, the nearest distance may be found, as in the third proposition aforegoing: 3. so likewise may the *Angles of Position* also.

PROP.

PROP. VI.

By knowing the nearest Distance of two Places, their Difference of Longitude, and one of their Latitudes, to find the Direct Position thereof from the other.

This Propoſition falls under the *firſt Caſe of Oblique Spherical Triangles*, and is thus reſolved: therefore,

As S. of the Diſtance of the two Places,
To S. of their X. of *Longitude*.
So is Sc. of the *Latitude* of the one Place given,
To S. of the *Direct Poſition* from the other as was ſo required.

PROP. VII.

By knowing the Latitudes of two places, and likewiſe their Difference of Longitude, to find,

1. *The diſtance in the Arch.*
2. *The direct Poſition from the firſt to the ſecond place.*
3. *The direct Poſition from the ſecond to the firſt place.*
4. *The Latitudes and Longitudes by which the Arch paſſeth.*
5. *The Courſe and Diſtance from Place to Place through thoſe Latitudes and Longitudes according to* Mercator.

I ſhall here make uſe of M. *Norwood*'s example of a Voyage from the *Summer-Iſlands*, unto the

§ 3. *Lizard:* now becauſe the work is various I have therefore illuſtrated it with a *Scheme*, and ſhall be as brief and facile as poſſible. *Therefore,*

In the *Triangle* ADE, let A be the *Summer-Iſlands*, whoſe *Latitude* is 32° 25′, AD the *Complement* thereof 57° 35′, let E repreſent the
Fig. 51. *Lizard* whoſe *Latitude* is 50° 00′, and ED the *Complement* thereof 40° 00′, and let their *Difference of Longitude*, namely the Angle ADE be 70° 00′, now D repreſenteth the *North-Pole*, and AE an Arch of a great Circle paſſing by theſe two Places: now ſee the operation.

1. By having the *Complements* of the *Latitudes* of the two Places, *viz.* AD 57° 35′, and ED 40° 00′, and their *Difference of Longitude*, namely the Angle EDA 70° 00′: you may find the neareſt diſtance EA to be 53° 24′; by *Caſe the* 9. § 5. *chap.* 5.

Fig. 51. 2. Then having found the neareſt diſtance in the *Arch* EA to be 53° 24′, (or 3204 Miles) the *Angle of Poſition* from the *Summer Iſlands* to the *Lizard*, namely the Angle DAE, may be found by *Caſe the* 1. § 5. *chap.* 5. to be 48° 48′, that is N.E. and 03° 48′ Eaſterly.

3. And alſo by the ſame *Caſe*, may the *Direct Poſition* from the *Lizard*, to the *Summer-Iſlands*, namely the Angle AED be found to be 81° 10′, that is W. by N. and 2° 25′ Weſterly.

4. In order to the finding the *Latitudes* and *Longitudes* by which the *Arch* paſſeth, firſt let fall the *Perpendicular* DB, ſo is the *Oblique*
Fig. 51. *Triangle* ADE converted into two *Rectangulars*, *viz.* ABD, and DBE: ſecondly, by *Caſe the* 8. § 4. *chap.* 5. you may find the length of the

Perpen-

Perpendicular DB to be 39° 26′, whose *Complement* is 50° 34′, which is the greatest *Latitude* by which the *Arch* ABE passeth, so the greatest *Obliquity* of the *Equinoctial* from that *Circle* is 50° 34′. — Thirdly, by *Case the* 9. § 4 *chap.* 5. you must find the *vertical Angles, viz.* ADB, and BDE, which will appear, the Angle ADB to be 58° 31′, and EDB to be 11° 29′ : now these things being obtained, the *Latitudes* by which the *Arch* passeth at every tenth degree of *Longitude* from A, may be found by resolving the several *Right-Angled Triangles, viz.* BDc, BDf, *&c.* substracting 10° from ADB 58° 31′, there remains BDc 48° 31′, and so for the rest as in the Table. Now by knowing these *Angles* last found, and the *Perpendicular* BD before found to be 39° 26′, you may by *Case the* 3. § 4. *chap.* 5. find the *Latitudes* of the several points A. c. f. g. h. i. B. and E. to be as in the subsequent Table. § 3. Fig. 51.

BDc	48°	31′
BDf	38	31
BDg	28	31
BDh	18	31
BDj	08	31

5. Thus having found the *Latitudes* and *Longitudes* of the *Arch*, and the other required parts aforementioned, we now come to shew how the *Course*, and the *Distance* from place to place according to *Mercator* may be found. So to find, first the *Course* and *Distance* Fig. 51.

	Latitude.		*Longitude.*	
A.	32°	25′	00	00′
c.	38	51	10	00
f.	43	34	20	00
g.	46	54	30	00
h.	49	04	40	00
i.	50	15	50	00
B.	50	34	60	00
E.	50	00	70	00

§. 3. Ac. now there is given the *Latitude* of A 32° 25′, and of c 38° 51′, and their *Difference of Longitude* is 10° 00′, now the *Proper Difference*
Fig. 51. *of Latitude* is 6° 26′, or 386′, and *Meridional Difference of Latitude* is 475′. Now knowing these things by proposition 2. § 2. *chap*. 8. you may find the *Course* from A to c, to be N. E. 51° 38′; and the *Distance* Ac to be 622′, and so those Rules prosecuted will shew the course and distance from c to f; from f to g; from g to h, *&c.* So of the rest, which for brevity sake I shall omit, and leave the Ingenious Seaman to Calculate at his Pleasure.

I might hereunto annex many more propositions of *Circular Sailing*, but because of the smallness of this Treatise, and that those Propositions already handled, being by the Ingenious Seaman well understood, will be sufficient to enable him to perform any other Conclusion in *Circular Sailing* whatsoever, I therefore here omit, and hasten forwards unto the other parts of this *Mathematical Treasury*.

A Ta-

§. 3.

A Table of Angles, which every Rumb maketh with the Meridian.

These on this side the W. incline towards the N. end of the Meridian	*Angles of Inclination with the Meridian.*		*These on this side the E. incline to the N. end of the Meridian.*
Rumbs.	North		Rumbs.
N. by W.	11°	15′	N. by E.
N. N. W.	22	30	N. N. E.
N. W. by N	33	45	N. E. by N.
North West	45	00	North East
N. W. by W.	56	15	N. E. by E.
W. N. W.	67	30	E. N. E.
W. by N.	78	45	E. by N.
West	90	00	East
W. by S.	78	45	E. by S.
W. S. W.	67	30	E. S. E.
S. W. by W.	56	15	S. E. by E.
South West	45	00	South East
S. W. by S.	33	45	S. E. by S.
S. S. W.	22	30	S. S. E.
S. and by W.	11	15	S. and by E.
Rumbs	South		Rumbs
These on this side the W. incline unto the S. end of the Meridian.			*These on this side the E. incline towards the S. end of the Meridian.*

Note that if you account in quarter of Points, add for one quarter 2° 48′, for one half 5° 37′, for three quarters 8° 26′, (not regarding the Seconds in Navigation.)

CHAP. IX.

Of SURVEYING.

** Which Instrument, and the Plain Table, I esteem as the two aptest Instruments for Surveying of Land*; i. e. *the Plain Table for small Enclosures, and the Semicircle for Champain Plains, Woods, and Mountains.*

IT hath been a custom among Modern Authors, that have treated on this Subject, that before they entred on the Work it self, to give the Description of the Instruments, used in; and chiefly appertaining to the Art of *Surveying* : *viz*. the *Circumferentor*, the *Theodolite*, the *Plain-Table*, and the *Semicircle* : concerning the descriptions of which Instruments I shall not here treat, but refer you unto those Authors that have largely and amply described them. I shall in this place onely demonstrate the Use of the *Semicircle* in taking the *Plots* of *Enclosures*, *Champain-Plains*, *Woods* and *Mountains* divers ways *; and also in taking of *Accessible*, and *Inaccessible Heights* and *Distances* ; and also I shall shew the use of a little Instrument called a *Protractor*, in the delineating on Paper the *Plot* of a *Field*, &c. which Instrument being so commonly known, and so generally used makes me omit the description thereof as superfluous. As

As for your *Chain*, I would have you, have it made of good round *Wyre*; to contain in length four *Poles*, or *Perch*, to be divided into an hundred equal parts called *Links*.

And here before we enter on the Work it self, it will be necessary to understand how by the *Protractor* to lay down an *Angle* of any quantity of degrees propounded, or to find the quantity of an *Angle* given.

SECT. I.

Of the use of the Protractor.

§. 1.

PROP. I.

By the Protractor, to Protract an Angle of any quantity of degrees propounded.

AN *Angle* may be laid down easily according to the directions of *Prop.* 5. §. 1. *Ch.* 4. *Fig.* 52. but because this is more usefull in *Surveying*, Know that if it be required to protract an *Angle* of 50 deg. having drawn the line A B at pleasure, place the Centre of your *Protractor* on C, and moving it by your *Protracting Pinn*, untill the *Meridional line* thereof be directly on the line A B, then make a Mark by the division of 50° on the *limb* of the *Protractor* as at D, and

§. .1 draw the line CD, ſo ſhall the Angle DCB, be an Angle of 50 degrees.

PROP. II.

By the Protractor given, to meaſure an Angle given.

This is performed by the line of *Chords* alſo, according to prop. 6. §. 1. chap. 4. and by the *Protractor* is found thus: Suppoſe DCB were an Angle whoſe Quantity were deſired, to find
Fig. 52. which, firſt the *Center* of the *Protractor* applyed unto the Angular point C, and its *Meridional line* lying juſtly with CB; you ſhall perceive the Point D, to touch the *limb* of the *Circle* at 50 deg. Therefore I conclude the Meaſure of the Angle DCB, to be 50 degrees.

SECT.

Plate III

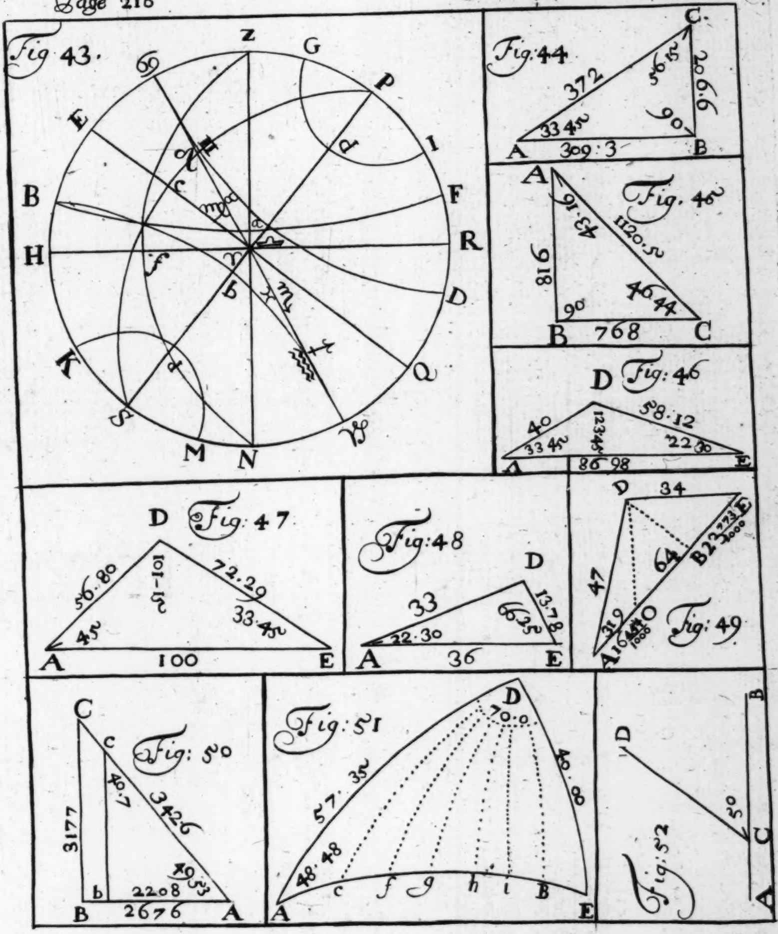

Fig 43.
Fig:44
Fig. 45
Fig: 46
Fig: 47
Fig:48
Fig: 49
Fig: 50
Fig: 51
Fig: 52

SECT. II. §. 2.

Of the Manifold Use of the Semicircle, in taking the Plots of small Enclosures, Plains, Woods, or Mountains divers Ways.

PROP. I.

How to take the Plot of a Field, by the Semicircle at one Station taken in any part thereof, from whence all the Angles may be seen, and measuring from the Station unto every Angle thereof.

Suppose ABCDEF were a Field, and 'tis required to take the Plot thereof: Having placed marks at all the Angles thereof, and made choice of your Station, which let be K; at which, place your Instrument; and turning it about untill the *Needle* hang over the *Meridian Line of the Chart*, there screw it fast: Then directing your sight to A, you'l find the Degree out by the *Index* to be 40° 15′: Then measuring KA with your *Chain* it appears to be 5 *Chains* and 20 *Links*, which note down in your *Field-book*: and so do by all the rest untill you have found all the Angles and Distances from your Station K, to each respective Angle, which finished your work will stand thus. *Fig.* 53.

Angles.

§. 2.

Angles.	D.	M.	C.	L.
A.	40	15	5	20
B.	88	00	6	10
C.	130	00	5	50
D.	200	00	7	00
E.	250	00	5	00
F.	310	00	5	20

PROP. II.

How to delineate on Paper any Observation taken according to the Doctrine of the last Proposition.

Upon your Paper draw a Line to represent the *Meridian line* as M, H, then Placing the Center of your *Protractor* on the point K, laying the *Meridian line* of the *Protractor* on the *Meridian line* M, H, then seeing the Angle at A was 40° 15′, make a Mark against 40° 15′ of the *Protractor*, as at A, and so do with all the other Angles, as you find them in your Table: Then remove your *Protractor*, and draw the Lines KA, KB, *&c.* This done lay down on each line his respective Measure, as it appeareth in the Table. Lastly draw the Lines AB, BC, *&c.* So have you on the Paper the exact Figure of the Field.

Fig. 53.

PROP.

§. 2.

PROP. III.

How by the Semicircle to take the Plot of a Field at one Station in any Angle thereof, from whence you may view all the other Angles, by measuring from the Stationary-Angle, unto all the other Angles.

Admit A, B, C, D, E, F, G, to be a Field, whoſe Plot is required: Place your *Semicircle* at G, and turning it about untill the *Needle* hang over the *Meridian line of the Chart*, and there ſcrew it faſt: Then direct your ſights to the ſeveral Angles, *viz.* B, C, D, *&c.* in order one after the other, and ſo ſhall eace reſpective Angle be found, as in the ſubſequent Table: Then with your *Chain* meaſure from your *Stationary-Angle* G, to all the other reſpective *Angles*, which done you have finiſhed, and the work ſtandeth thus. *Fig.* 54.

Angles.	D.	M.	C.	L.
B.	40	00	5	00
C.	88	00	6	00
D.	120	15	6	40
E.	165	00	6	30
F.	193	00	3	40
A.	348	07	4	00

PROP.

§. 2.

PROP. IV.

How to delineate any Observation taken according to the Doctrine of the last Proposition.

Upon your Paper draw a streight line as M, N, then take a point therein as G, to represent the *Stationary-Angle*, to which point apply the *Center* of your *Protractor*, (in all respects as is Fig. 54. before taught) then according to the Notes in the Table, prick off all the Angles, *viz.* B, C, *&c.* according to their due quantity, then draw all the lines, *viz.* GB, GC, GD, *&c.* and on them place their respective measure (as appeareth in your Notes) lastly draw the lines AB, BC, CD, *&c.* So is there on the Paper the exact Figure of the Field, as was required.

PROP. V.

How by the Semicircle to take the Plot of a Field at two Stations, by measuring from each Station to the visible Angles: the Field being so Irregular that from no one Place thereof, all the Angles can be seen.

Admit A, B, C, D, E, F, G, H, I, K, to be the Figure of a Field, whose Plot is required: having made choice of your two *Stations*, *viz.* Q, and P, and placed Marks in all the Angles: Then place your *Semicircle* at Q, and there Fig. 55. fix it with the *Needle* hanging over the *Meridian* of the *Chart*, represented by R, Q, X, and direct your sights unto all the *visible Angles*, viz.

A, B,

A, B, C, D, E, and F, and note down the Quantity of each Angle in your *Field-book*: Then measure with your *Chain* from your *Station* Q, to the *Angles* A, B, C, D, E, and F, and their length so found, note down in your *Field-book* also. §. 2.

Fig. 55.

This done direct your sight unto your second *Station* P, and note down in your *Field-book* the *degree* of *Declination*, of your *second-station* P, from the *Meridian*. Then measure the *Stationary Distance* PQ with your *Chain*, and note it down in your *Field-book* also.

Then remove the Instrument unto P, your *second-station*, and there fix it with the *Needle hanging* over the *Meridian line* of the *Chart* represented by TPB, then direct your sights to the several *visible Angles* at this second Station, *viz.* F, G, H, I, and K, in order one after another, and note down the Quantity of each Angle in your *Field-book*: Then with your *Chain* measure from your *Station* P, to these several Angles G, H, I, and K, (in all respects as at the first station Q.) and their length so found note down in your *Field-book* likewise: So have you finished your Observation, and your work standeth thus.

Fig. 55.

The

§. 2.

The Observation taken at the first Station Q.

Fig. 55.

Angles.	D	M	C	L
A	50	00	6	60
B	80	00	7	65
C	140	12	12	00
D	220	07	11	10
E	270	05	12	60
F	330	00	6	00

The *Declination* of the *Station* P, from the *Meridian* R Q X, is 30° 00′, and the *Stationary distance* Q P is 9 *Chains*.

The Observation taken at the second Station P.

Angles.	D	M	C	L
F	227	11	00	00
G	297	00	12	00
H	347	16	9	90
I	60	00	6	00
K	90	00	6	26

Fig. 55.

☞ Note that the manner of taking the Plot of a large *Champain Field*, at many Stations, is almost the same with this Proposition; for he that can do the one, can also perform the other: therefore for brevity sake I here omit it as superfluous.

PROP.

§. 2.

PROP. VI.

How to delineate any Observation taken according to the Doctrine of the last Proposition.

Upon your Paper draw the *Meridian-line* RQX, then place the Center of your *Protractor* on Q, (representing your first Station) and its *Meridional-line* lay equal to RQX, then prick off the *Angles visible* at your first *Station* Q, *viz.* A, B, C, D, E, and F, Of their due quantity, then draw QA, QB, *&c.* laying on them their corresponding measure, noted in your Field-book. Now because your *second Station* P, doth decline 30° 00′, from the *Meridian* RQX, prick off 30° 00′, and draw PQ, making it 9 *Chains* as in your Field-book appeareth, so doth P represent your *second Station.* Then in all respects as before, place your *Protractor* at P your *second Station*, and draw the *Meridian* TPB *parallel* to RQX, then prick off the several *Angles*, *viz.* F, G, H, I, and K, Of their due quantity, and then draw PF, PH, PI, *&c.* of their due length. Lastly draw the lines AB, BC, CD, *&c.* and so shall you have on your Paper the exact Figure of the Field as required. *Fig.* 55.

PROP.

PROP. VII.

How by the Semicircle, to take the Plot of a Field at two Stations, which lieth remote from you, when either by opposition of Enemies you may not, or by some other Impediment you cannot come into the same.

Admit the Figure A, B, C, D, E, F, to be a Field into which by no means you can possibly enter, and yet of necessity the Plot thereof must be had, for the obtaining of which chuse any *two Stations*, it mattereth not whether near at hand or far off, so that all the *Angles* may be seen. Let your *two Stations* be H and L, (the full length of the Field if possible) then place your Instrument at H, and fixing it as is
Fig. 56. afore shewed, direct your sights to the several *Angles* of the *Field*, viz. A, B, C, *&c.* orderly one after another, observing their degrees as is afore taught, noting it down in your *Field-book*: then take up your Instrument, leaving a mark in its room at H, And measure with your *Chain* from H unto L, your *second Station*, which note down in your *Field-book*; Then placing your Instrument at L, your *second Station*, and as is before taught, fixing it there, make the like Observation to the several *Angles*, viz. A, B, C, D, *&c.* as at the *first Station* H, and note it down in your *Field-book* also, And having so done you have finished, and your Work standeth thus.

Observa-

§. 2.

Observations at the first Station H, are

1 Angles	D	M
A	104	00
B	88	07
C	59	00
D	48	00
E	26	00
F	21	30

The Angle from H the first Station, unto L the second Station, is 180° 00′, the *Stationary distance* HL, is 60 *Chains*. *Fig.* 56.

Observations at the second Station L, are

2 Angles	D	M
A	16	00
B	39	00
C	50	09
D	74	00
E	100	00
F	29	15

PROP. VIII.

How to delineate any Observation taken according to the Doctrine of the last Proposition.

Upon your Paper draw a Line as HL, which make equal to 60 *Chains*, then placing the Center of your *Protractor* on H, your *first Station*, prick off all the Angles A, B, C, *&c.* as *Fig.* 56. you find them in your Field-book, and draw HA, HB, HC, *&c.* at pleasure: then remove your *Protractor* unto your *second Station* L, placing it as before, and prick off all the Angles

§ 2. A, B, C, D, *&c.* as you find them in your Field notes; and draw the lines LA, LB, LC, *&c.* at length untill they interſect the former

Fig. 56. lines, HA, HB, *&c.* in the Points A, B, C, *&c.* which *Points of Interſection* are the *Angles* of the *Field.* Laſtly draw AB, BC, CD, *&c.* So ſhall you have on your Paper the Figure of your Field, required.

PROP. IX.

How by the Semicircle, to take the Plot of a great Champain-Plain, Wood, or other overgrown Ground, by meaſuring round about the ſame, and making Obſervation at every Angle thereof.

Admit A, B, C, D, be the figure of a *Large overgrown Champain-Field*; whoſe Plot is required. Firſt Place your Inſtrument at A, laying the *Index* on the *Diameter*; and turn it about, untill you eſpy the *Angle* at D, and there fix it faſt: and direct your *ſights* to B, and note the *Degree* cut by your *Index*, in your *Field-book*, (as afore is taught) then remove your Inſtrument to B, and there make the like obſervation, and ſo to C, and D, noting it down in your *Field-book*, as afore. Then with your *Chain*,

Fig. 57. meaſure the Sides AB, BC, CD, and DA, whoſe length note down in your *Field-book*, and ſo you have finiſhed and your work ſtandeth thus.

Angles.

Angles.	D	M	C	L
DAB	100	00	12	20
ABC	117	15	10	00
BCD	71	30	19	20
CDA	71	15	12	20

PROP. X.

How to delineate any Observation taken according unto the Doctrine of the last Proposition.

Upon your Paper draw the line AB, at Pleasure, and placing the Center of your *Protractor* on the Point A, prick off an *Angle* of 100°, and draw AD, setting on it, and also on AB, their corresponding measure, in your notes: Then on B, protract an Angle of 117° 15′, draw BC of its due length: Then draw the line CD, so have you the exact figure of the Field, on your Paper. *Fig.* 57.

PROP. XI.

How to take the Plot of any Field, by the help of the Chain only.

Admit the Figure A, B, C, D, E, to represent a Field whose Plot is required. To obtain the which, first measure the sides CD, CB, and BD, and note their due length down in your *Field-* *Fig.* 58.

§. 2. *book*, and then measure the Sides CA, and BA, and then note down their Length in your *Field-book.* Then measure the sides BE, and ED, (for the sides BC, and BD, were before known) which note down in your *Field-book.* So is

	Sides.	*Ch.*	*Lin.*
In the Triangle CBD	CD	5	97
	CB	8	28
	BD	8	25
In the Triangle CAB	CA	4	24
	CB	8	28
Fig. 58.	BA	6	51
In the Triangle BED	BE	5	28
	ED	5	25
	BD	8	25

your Field A, B, C, D, E, reduced into three *Triangles*, viz. CBD, CAB, and BED, the length of whose sides are all known, thus you have finished, and the works stands as you see.

PROP. XII.

How to delineate any Observation, taken according to the Doctrine of the last Proposition.

Upon your Paper, draw a streight line, as CD, make it 5 *Chains*, $\frac{97}{100}$, take CB in your *Compasses*, and strike an *Obscure Arch*; then take
Fig. 58. BD, and with that extent in D, cross the former *Arch* in B, and draw BC, and BD. Then take in your *Compasses* BE, and on B, strike an *Obscure Arch*, then take DE, and also cross the

the former *Arch* in E, and draw BE, and ED. §. 2.
Lastly, take the line CA, and on C strike an *Obscure Arch*, then take AB, and on B, intersect the former *Arch* in A, then draw CA, and AB, so have you on your Paper the exact figure of the Field A, B, C, D, E, as was required. Fig. 58.

SECT. III.

Of finding the Area or superficial Content of any Field, lying in any Regular or Irregular Form: by reducing the Irregular Fields into Regular Forms. §. 3.

HAving already shewed how to take the Plot of any Field divers ways, by the *Semicircle* and *Chain*, and also by the *Protractor* how to delineate the Draught thereof on Paper, *&c.* I now come to shew how the *Area* or *superficial Content* of a Field may be attained, *i. e.* how many *Acres*, *Roods* and *Perches* are therein contained. To which end know; *That a Statute Pole or Perch contains* 16½ *Feet*; *that* 40 *of those Perches in length, and* 4 *in breadth makes an Acre.* So that an *Acre* contains 160 *Perches*, and a *Rood* 40 *Perches*; according to the Statute 33, of *Edward* the *First*.

§. 3. Now the Original of the Menſuration of *Land*, and all other *Superficies*, depends on the Menſuration of certain *Geometrical Figures*; as a *Triangle*, *Square*, &c. which may be meaſured according to the directions of §. 2. *chap.* 4 of *Geometry*: It would therefore here be ſuperfluous to make a repetition of things already handled: I ſhall therefore omit it, and come to ſhew how any Field lying in any *Irregular Form*, may be meaſured by converting it into *Regular Figures*; for it ſeldom happeneth, but that the Plot of a Field, is either a *Trapezium* *, or a many-ſided *Irregular Figure*: therefore I ſhall firſt ſhew how to find the Content of a *Trapezium*. Secondly, of any many ſided *Irregular Figure*; and thirdly, how to reduce any number of *Perches* into *Acres*, &c. and on the contrary any number of *Acres*, into *Roods* and *Perches*.

* *Is a Quadrangle, whoſe ſides are not Parallel, nor equal.*
Euclides poſtulat hanc fabricam Trapezium, tanquam menſulam vocari: & ſanè nominis ejus ratio Geometrica nulla eſt: P. Rami *lib.* 14 *pag.* 94.

PROP. I.

How to find the Area or ſuperficial Content of a Trapezium.

Trapeziums are *Quadrangles* of ſundry forms: yet take this as a general Rule, whereby their Content may be found. Admit it be required to find the *Area* or *ſuperficial Content* of the *Trapezium* ABCD, to find which, firſt by drawing the

the *Diagonal* AD, you reduceth it into two *Triangles*, ABD, and ADC. Then by prop. 3. §. 1. of Chap. 4 let fall the two *Perpendiculars* on AD, from B, and C, Then by prop 3. §. 2 Ch. 4. find the *superficial Content* of the two *Triangles* ABD, and ADC, which added together, is the Content of the *Trapezium*; by which Rule the Content of the *Trapezium*, A,B,C,D, is found to be 630 *Perches*. §. 3. Fig. 59.

PROP. II.

To find the Area *or superficial Content of a many-sided Irregular Figure.*

Admit A, B, C, D, E, F, G, to be an *Irregular many-sided Figure*, representing a Field whose Content is required: now in regard the Field is *Irregular*, therefore reduce it into *Triangles*, *viz.* ABC, ACG, EDG, DEG, and DFG, and then find the Content of all the said *Triangles*, by prop. 3. §. 2. Chap. 4 and add their Contents together; so shall that Sum be the Content of the said Figure; and so do for any other. Fig. 60.

PROP. III.

How to reduce any Number of Perches into Acres, and on the contrary, Acres into Perches.

To find how many *Acres* are contained in any Number of *Perches* given, you must consider that 160 *Perches* do make a *Statute Acre*, therefore if you divide the Number of *Perches*

§. 3. propounded, by 160, the Quotient is the number of *Acres* contained therein; and if there be a remainder which exceed 40, then divide it by 40, the Quotient ſhall be *Roods*, and the remainder *Perches*.

But on the contrary, if it were required to find how many *Perches* are contained in a certain Number of *Acres* propounded. You muſt multiply the Number of *Acres*, by 160: the product ſhall be the *Perches* contained therein.

☞ *It may be here expected, that I ſhould ſhew how to reduce cuſtomary Meaſure to ſtatute Meaſure; and alſo that I ſhould treat of the Diviſion and Separation of Land. But becauſe Mr.* Rathborne, *and of late Mr.* Holwell, *hath ſufficiently explained the ſame, by many varieties, I ſhall for brevity ſake omit it, and leave you to conſult thoſe Authors.*

SECT.

SECT. IV.

Of the Use of the Semicircle in taking Altitudes, Distances, &c. §. 4.

PROP. I.

How by the Semicircle to take an Accessible Altitude.

ADmit AB, be the Height of a *Tower*, which is required to be known. First placing your *Semicircle* at D, (with the Arch downwards *Fig.* 61. and the two sights fixed) place it *Horizontal* * and screw it fast; Then move your *Index*, till through the sights thereof, you espy the top of the *Tower* at B, and observe what degree the lower part of the *Index* cutteth and that will be equal unto the Angle at D 50 deg. Then measure the distance DA, which let be 299 Feet. Now the heighth of the Tower AB, is found, according to prop. 1. §. 2. Chap. 5. thus,

As Sc. *V*. at A 50° 00′,
To Log. cr. DA 299 Feet,
So is S. *V*. at A 50 00,
To Log. AB $356\frac{3}{10}$ Feet the height of the *Tower* AB required.

* *Which to do is no more than thus; with a Thread and Plummet fastened at the Center of the Semicircle, so that it hath liberty to play, move the Semicircle until the Thread playeth against 90 deg. then screw it fast, and it is* Horizontal.

PROP.

§. 4.

PROP. II.

How by the Semicircle to take an Inaccessible Altitude, at two Stations.

Let AB be a *Tower* whose height is required; having placed your Instrument at E, as before direct your sights unto the Top of the *Tower*
Fig. 61. at B, and finding the *Degree* cut by the *Index*, to be 23° 43′, I say it is the Quantity of the Angle at E: Now by reason of Water, or such like Impediment, you can approach no nearer the Base of the Tower, than D, Therefore measure ED, which is found to be 512 Feet, then at D, make the like Observation, and the Angle at D, appeareth to be 50° 00′, whose *Complement* is the Angle DBA, 40° 00′, and the *Complement* of the Angle E 23° 43′, is the Angle EBA 66° 17′: Now if the lesser Angle at B, be taken out of the greater, the remainder is 26° 17′, the Angle EBD: Now first to find the side BD, of the *Trangle* EBD, say according to *prop.* 1. §. 3. *chap.* 5. thus.

As S. *of V.* EBD, 26° 17′,
To Log. cr. ED 512 Feet.
So is S. *of V.* at E 23° 43′,
To Log. cr. BD 465$\frac{2}{10}$ Feet required.

Now to find the Height of the *Tower* AB, say according to *prop.* 2. §. 2. *chap.* 5. thus.

As Radius or S. 90°,
To Log. cr. DB 465$\frac{2}{10}$ Feet found.
So is S. *of V.* BDA 50° 00′,
Fig. 61. *To Log.* cr. BA 356$\frac{3}{10}$ Feet, which is the height of the Tower required.

☞ Note

☞ Note that in taking any manner of *Altitude* the height of your *Instrument* must be added unto the height found, and that will give you the *True Altitude* required. §. 4.

PROP. III.

How by the Semicircle to take an Inaccessible Distance at two Stations.

Admit A, and B, be the two Stations, from either of which it is required to find the distance unto the *Church* at C; placing your Instrument at B, the *Index* lying on the *Diameter*, and direct your sights unto the *Church* at C, fasten your Instrument, and turn your sights about untill you see through your sights, your second Station at A, so will you find your *Index* to cut *Fig.* 62. 30° 00′, which is the Quantity of the Angle ABC. Then measure the distance AB, which is found to be 250 Yards, then with your Instrument at A, make the like Observation as before, and you will find the Angle BAC to contain 50° 00′. Now by the third *Maxim* of *Plain Triangles* §. 1. *Chap.* 5 you find also the Angle ACB, to be 100° 00′: now to find the distance AC, and BC, you may by their opposite proportion according to *prop.* 1. §. 3. *chap.* 5. find the distance of AC, thus.

As S. *of V.* at C 100° 00′,
To Log. cr. AB 250 yards.
So is S. *of V.* B 30° 00′,
To Log. cr. AC 127 yards. Which is the distance of the *Church* from A.

Now

§. 4. Now to find the diſtance BC, ſay,

As S. *of V.* at A 100° 00′,
To Log. cr. AB 250 yards.
So S. *is of V.* at A 50° 00′,
To Log. cr. BC $194\frac{4}{10}$ yards, which is the diſtance of the *Station* B, from the *Church* at C.

PROP. IV.

How to find the Horizontal line of any Hill or Mountain, by the Semicircle.

Let Figure 63 be a *Mountain*, whoſe *Horizontal-line* AB is required to be found: to find which, place your Inſtrument at A, and having cauſed a Mark to be placed on the Top of the *Mountain* at C; (of the juſt height of your Inſtrument) then move your *Index*, untill through the ſights thereof you eſpy the Mark at C, ſo will you find the Quantity of the An-
Fig. 63. gle CAD, to be 50° 00′, and by conſequence the Angle ACD to be 40° 00′, then meaſure up the *Hill* AC, which is 346 yards. Now having obtained theſe ſeveral things, 'tis required to find the length of AD part of AB; to find which ſay,

As Radius or S. 90°,
To Log. cr. AC 346 Feet.
So is Sc. *of V.* at A 50° 00′,
To Log. cr. AD $222\frac{4}{10}$ Feet.

Now ſeeing the *Hill* or *Mountain* deſcendeth on the other ſide, you muſt place your Inſtrument at C, and direct your ſights unto the *Bottom* at B, and the Angle DCB will be found 50° 00′, and the Angle CBD 40° 00′. Then meaſuring down the *Mountain* as CB, it appeareth

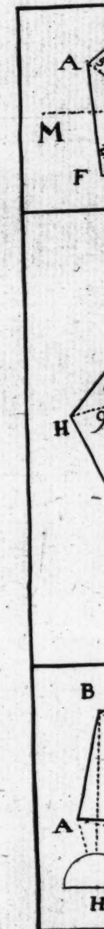

Plate IV

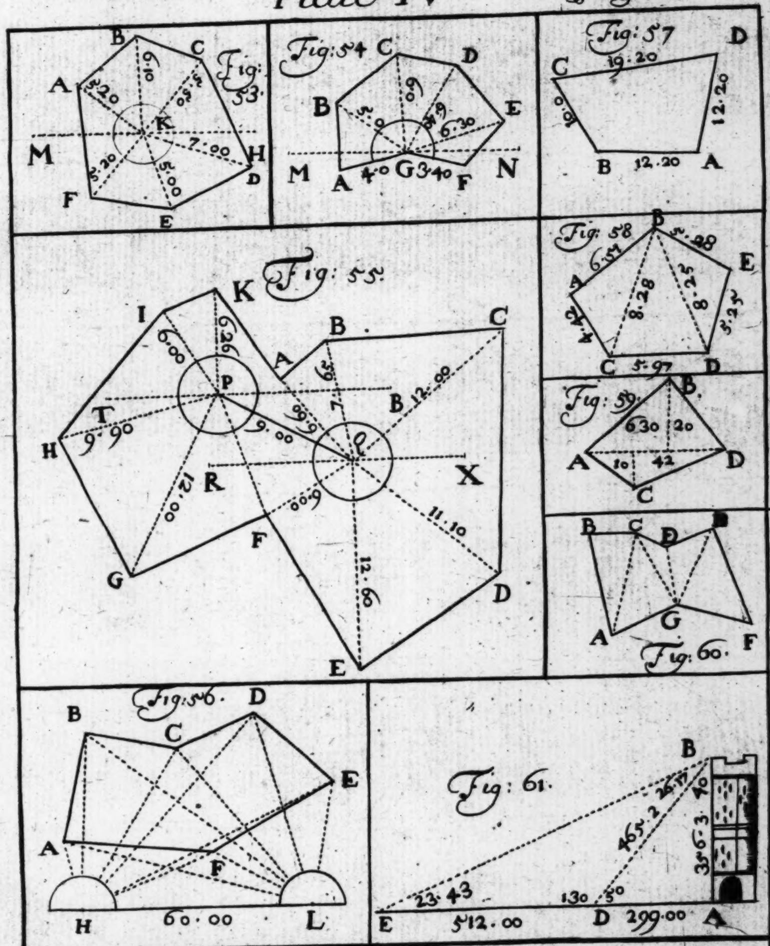
Fig: 53.
Fig: 54
Fig: 57
Fig: 58
Fig: 59
Fig: 55.
Fig: 60.
Fig: 56.
Fig: 61.
60 · 00
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reth to be 415 Feet; then have you the Angles DCB, and CBD. §. 4.

To find DB, part of AB, ſay,

As Radius or S. 90°,

To Log. cr. CB 415 Feet.

So is S. *of V.* BCD 50° 00′,

To Log. cr. DB, 318 Feet: Now AD $222\frac{4}{10}$ *Fig.* 63.
Feet added thereunto produceth AB $540\frac{4}{10}$ Feet, which is the *Horizontal line* required of the *Mountain* ACBD.

☞ Note that when you come to delineate a Field wherein are *Hills*, you muſt protract the line AB, inſtead of the *Hypothenuſal* Lines AC, and CB, and 'twill be neceſſary to diſtinguiſh thoſe kind of Fields, by ſhadowing them off with *Hills* and *Dales*.

SECT. V.

How to find whether Water may be conveyed from a Spring-Head unto any appointed Place. §. 5.

THE Art of conveying of *Water* from a *Spring-Head* unto any appointed Place, hath a ſpecial reſpect unto meaſuring, and therefore I think it not amiſs to aſſert it in this place, and enroll it under the Title of *Surveying*.

In

§. 5. In the performance of which we make uſe of a *Water-level*, the Conſtruction and making whereof is ſufficiently known to thoſe who make *Mathematical Inſtruments*: Now if it were required to find whether Water may be conveyed in *Pipes*, &c. to any Place aſſigned: to perform which obſerve theſe Rules.

Firſt at ſome 10, 20, 30, 40, 60, or 100 yards diſtant from the *Spring-head* in a right line towards the Place unto which your Water is to be conveyed. Place your *Water-level*, being prepared of two *Station Staves* with moveable *Vanes* on each of them, graduated alſo after the uſual Manner: Cauſe your firſt *Aſſiſtant* to ſet up one of them at the *Spring-Head*, *Perpendicular* unto the *Horizon*, and your ſecond *Aſſiſtant* to erect another, as far from your *Water-level* towards the Place to which the Water is to be conveyed, as your *Water-level* is diſtant from the *Spring-head*: Now the *Station-ſtaves* in this order erected, and your *Water-level* placed preciſely *Horizontal*, go unto the end of the *Level*, and looking through the ſights, cauſe your firſt *Aſſiſtant* to move a Leaf of Paper, up or down your *Station ſtaff*, untill through the ſights you eſpy the very edge thereof, and then by ſome known *ſign* or *ſound*, intimate to your *Aſſiſtant* that the Paper is then in its true poſition, then let the firſt *Aſſiſtant* note againſt what Number of *Feet*, *Inches*, and parts of an *Inch* the edge of the Paper reſteth; which he muſt note down in a Paper. Then your *Water-level* remaining immoveable, go to the other end thereof, and looking through the ſights towards your other *Station-ſtaff*, cauſe your

your ſecond *Aſſiſtant* to move a Leaf of Paper along the *Staff*, till you ſee the very edge thereof through the ſights, and then cauſe him by ſome known *ſign* or *ſound*, to take notice what number of *Feet*, *&c.* are cut by the ſaid *Paper*, which let him keep, as your firſt *Aſſiſtant* did. §. 5.

This done let your firſt *Aſſiſtant* bring his *Station-ſtaff* from the *Spring-head*, and cauſe your *ſecond Aſſiſtant* to take that *Staff*, and carry it forwards towards the Place, unto which the Water is to be conveyed; ſome 30, 40, 60, or 100 yards, and there to erect it *Perpendicular* as before, letting your *ſecond Aſſiſtant's ſtaff* ſtand immoveable, and your firſt *Aſſiſtant* to ſtand by it: Then in the *Midway* between your two *Aſſiſtants*, place your *Water-level* exactly *Horizontal*, and looking through the ſights thereof, cauſe your firſt *Aſſiſtant*, and after that your ſecond, to make their ſeveral obſervations in all reſpects as before.

In this manner you muſt go along from the *Spring-head*, to the place unto which you would have the Water conveyed, and if there be never ſo many ſeveral Stations, you muſt in all of them obſerve this manner of work preciſely; ſo that by comparing the notes of your two *Aſſiſtants* together, you may eaſily know whether the *Water* may be conveyed from the *Spring-head*, or not, by calling your two *Aſſiſtants* together, and cauſing them to give in their notes of obſervation at each *Station*, which add together ſeverally: Then if the Notes of the *ſecond Aſſiſtant*, exceed the Notes of the *firſt Aſſiſtant*, take the leſſer out of the greater, and the

§. 5. the remainder will ſhew you how much the appointed *Place*, to which the *Water* is to be conveyed, is lower than the *Spring-head.*

The firſt Aſſiſtant's Note.			
Station.	*Feet.*	*Inch.*	*Parts.*
1	15	3	.50
2	2	1	.25
3	1	6	.00
Sum	18	10	.75

The ſecond Aſſiſtant's Note.			
Station	*Feet.*	*Inch.*	*Parts.*
1	3	2	.75
2	14	0	.25
3	3	11	.00
Sum	21	2	.00

By theſe two Tables you may perceive that the Notes of the firſt *Aſſiſtant* collected at his ſeveral Stations, being added together, amounts unto 18 *Feet*, 10 *Inches*, and $\frac{75}{100}$ or $\frac{3}{4}$ of an *Inch:* and the Notes of your ſecond *Aſſiſtant* collected at his ſeveral Stations, amounts unto 21 *Feet*, 2 *Inches:* So that the number of the *firſt Aſſiſtant's Obſervations*, being taken from the *ſecond's*, there will remain 2 *Feet*, 3 *Inches*, and $\frac{25}{100}$ or $\frac{1}{4}$ of an *Inch.* And ſo much is the *place* unto which the *Water* is to be brought, lower than the *Spring-Head*, according to the ſleight *Water-Level*, and therefore the Water may eaſily be conveyed thither. And here obſerve theſe Notes.

☞ 1 In

☞ 1. In your Passage between the *Spring-head*, and the appointed *Place*, from *Station* to *Station*, you must observe this order, that your first *Assistant* at every *Station* must stand between the *Spring-head*, and your *Water-level*: otherwise great Errours will ensue. §. 5.

☞ 2. That if the Notes of your *first Assistant*, exceed the Notes of the *second Assistant*, then 'tis impossible to bring the *Water* from that *Spring-head* unto the *appointed place*, but if their Notes are equal, it may be done, if the distance be but short.

☞ 3. That the most approved Authors concerning this particular do aver, that at every *Mile's* end there ought to be allowed 4½ *Inches* more than the *Streight-level*, for the current of the *Water*.

☞ 4. That if there be any *Mountains* lying in the way betwixt the *Spring-head* and the *Place* to which the *Water* is to be conveyed, you must then cut a *Trench* by the side of the *Mountain*, in which you must lay your *Pipes* equal with the *streight Water-level*, with the former allowance: and in case there be a *Valley*, you must then make a *Trunk* of strong wood, well under-propped with *strong pieces* of *Timber*, well *Pitched*, or *Leaded*, as is done in divers places between *Ware* and *London*.

☞ 5. That when the *Spring* will have too violent a *Current*, you must then convey your *Water* to the place *assigned*, by a *Crooked* or *Winding line*, and you also ought to lay the *Pipes*, the one up, and the other down, that thereby the *Violence* of the *Current* may be stopped.

CHAP. X.

Of MEASURING,

Of Board, Glass, Tiling, Paving, Timber, Stone, and Irregular Solids, such as Geometry can give no Rule for the Measuring thereof.

SECT. I.

§ 1. *Of the Measuring of Board, Glass, Paving, Tiling, &c.*

I Have already in the fourth Chapter of this Book, and the second Section thereof, applyed *Geometry* to the finding out of the *Superficial Content* of all *Regular Superficies.* I have also in the ninth Chapter, and the third Section thereof, shewed how the *Superficial Content* of any *Irregular Superficies* may be found, by reducing

cing them into *Regular Forms*: which I have explained amply in that Section, I shall therefore here be as plain and brief as is possible. §. 1.

PROP. I.

To Measure a Piece of Board, Plank, Glass, &c.

In Measuring of *Board*, *Glass*, &c. *Carpenters* and other *Mechanicks* measure by the *Foot*, 12 *Inches* unto the *Foot*; so that a *Foot* of *Board*, or *Glass*, contains 144 *Square Inches*.

Now if a Piece of *Board*, *Plank*, or *Glass*, be required to be measured, let it be either a *Parallelogram*, or *Tapering Piece*: first by the Rules aforegoing find the Content thereof in Inches, and that Product divide by 144, the Quotient is the Content of that *Superficies* in *Feet*.

PROP. II.

To measure Tiling, Flooring, Roofing, and Partitioning-works.

In *Tiling*, *Flooring*, *Roofing*, and *Partitioning-work*, *Carpenters*, and other *Workmen*, reckon by the *Square*, which is 10 Feet every way; so that a *Square* containeth 100 *Feet*: Example.

There is a *Roof* 14 *Feet* broad, what length thereof shall make a *Square*? Divide 100 by 14, it yields $7\frac{1}{7}$ Feet.

§. 1. Now if you have any Number of Feet given, and the Number of *Squares* therein contained are required, divide that Number by 100, the product is *Squares*.

PROP. III.

To measure Paving, Plaistering, Wainscotting, and Painting-work.

In *Paving*, *Plaistering*, *Wainscotting*, and *Painting-work*, *Mechanicks* reckon by the *Yard Square*, so each *Yard* is equal unto 9 *Square Feet*.

By the Rules aforegoing find the *Superficial Content* of the *Court*, *Alley*, &c. in Feet: which divide by 9, the Quotient is the Number of *Yards* in that work contained.

SECT. II.

§. 2. *Of the Measuring of Timber, Stone, and Irregular Solids.*

IN *Superficial Measure* a *Superficial Foot* contains 144 *Square Inches*; but in *Solid Measure* a *Foot* contains 1728 *Cubick Inches*. Now having already in the fourth Chapter of this Book, and the third Section thereof, largely applyed *Geometry* unto the Measuring of all *regular*

Regular Solids, I shall therefore in this Place be as brief as possible, only I shall be somewhat larger in the Mensuration of *Irregular Solids*, which is of special Moment in sundry parts of the *Mathematical Practices*. §. 2.

PROP. I.

How to Measure any kind of Timber, or Stone, whether Three-square, Four-square, Many-square, Round, or of any other fashion, provided it be streight and equal all along.

To perform which first by the Rules aforegoing in *Chap.* 4. §. 2. get the *Superficial Content* at the End, and then say,

As 144, the Inches of the *Superficial Content* of the End of a *Cubick Foot*,

To a Cubick Foot containing 1000 *parts*;

So is the Superficial Content of the End of any piece of *Timber*,

To the Solid Content of one Foot length of the said *piece of Timber*.

According to which Mr. *Phillips* calculated the ensuing Table, which I have thought fit hereunto to annex.

Case 2. *Or the solid Content in Feet*, &c. *may be found otherwise thus.*

By the Rules aforegoing find the Content of the End of the piece of *Timber* in Inches, which Content multiply by the length of the said piece of *Timber*, or *Stone* in Inches, and that *Product* divide by 1728, it produceth the *Solid*

§. 2. *Content* of that Piece of *Timber*, or *Stone*, in Feet, and parts of a Foot.

A Table shewing the Solid Content of one Foot-length of any Piece of Timber, according to the Superficial Content at the End thereof.

The Inches of the Content at the End.	*Feet.*	*Parts.*	*The Inches of the Content at the End.*	*Feet.*	*Parts.*
1	0	007	200	1	398
2	0	014	300	2	083
3	0	021	400	2	778
4	0	028	500	3	472
5	0	035	600	4	167
6	0	042	700	4	861
7	0	049	800	5	556
8	0	056	900	6	250
9	0	062	1000	6	944
10	0	069	2000	13	888
20	0	139	3000	20	833
30	0	208	4000	27	778
40	0	278	5000	34	722
50	0	347	6000	41	666
60	0	417	7000	48	711
70	0	485	8000	55	555
80	0	556	9000	62	500
90	0	625	10000	69	444
100	0	694	20000	138	888

PROP.

§. 2.

PROP. II.

To measure Round Timber which is Hollow : or any other Hollow Body.

If *Hollow Timber* be to be measured, first measure the *Stick* as though it were not *Hollow*, then find the *Solidity* of the *Concavity*, as though it were *Massie Timber*, then substract this last found Content, out of the whole Content before found, the remainder is the Content of that *Hollow Body*.

PROP. III.

To Measure Tapering Timber, or Stone.

Those *Tapering Bodies* are either *Segments of Cones*, or *Pyramids* : now the way to measure such bodies, is demonstrated in Prop. the 4. and 5. §. 3. Chap. 4 : But now to find the Content of these *Segments* do thus : measure the *Solidity* of the whole *Cone*, or *Pyramid*, and then find the Content of the Top part thereof cut off, (as if it were a *Cone*, or *Pyramid* of it self) and the Content thereof, deduct from the Content of the whole *Cone*, or *Pyramid* : so shall the remainder be the Content of the *Segment* required : which reduced into Feet gives the Solid Content of that *Piece of Timber* in *Feet*. Now to find the length of the *Top part* cut off, from the *Cone*, or *Pyramid*, say,

As the Difference of the breadth of the two Ends,
To the length between them :

§. 2. *So is the breadth of the greater End,*
To the whole length of the Cone, or Pyramid.

PROP. IV.

How to find the Solid Content of any Solid Body, in any strange form, such as Geometry can give no Rule for the measuring thereof.

These strange forms are either *Branches* in *Metal, Crowns, Cups, Bowles, Pots, Screws,* or *Twisted Ballisters,** or any other *Irregular Solid,* that keep not in thickness one Quantity, but are thicker in one place, than in another, so that no man by *Geometry,* is possible to measure their *Solidity.*

* *Whose Surface is bounded by a Line called by* Proclus *a* Helicoides, *but it may also be called a* Helix, *a Twist or Wreath,* &c.

Now for the finding the Content of any such like *Irregular Body* in Inches or Feet, do thus: Cause to be made a *Hollow Cube,* or *Parallelepipedon,* so that you may measure it with an Inch-Rule without Difficulty, and so to know the true Content of the whole, or any part thereof at pleasure within the *Concavity:* Then take some other convenient Vessel, and put pure Spring-water therein; then having filled the Vessel to a known Measure, make a Mark precisely round the very edge of the Water, then take the *solid body* and put it therein, then take out as much of the Water (as by means of the *body* put therein) is arisen above the Mark, untill the Water do justly touch at the Mark again: then put the Water taken forth into the

Hollow

Hollow Cube, and find the *ſolid Content* thereof (being transformed into a *Cubick Body*) in *Feet*, *Inches*, and parts of an *Inch*: Which Content is the juſt *ſolidity of the Body* put into the Water. (*Archimedes* by this Propoſition found the deceit of the *Crown of Gold* which *Gelo* the Son of *Hiero* had vowed unto his *Gods*: now the Workmen had mixed *Silver* with the *Gold*, which Theft was diſcovered by the great skill of *Archimedes*) *. And herein you muſt be very curious not to ſpill any of the Water, or take out of the Veſſel, or put into the *Hollow Cube*, any more than the juſt quantity ariſen above the Mark, for if you do it will produce infinite Errours, and thus may the *Solidity* of any *Irregular Body* be found. §. 2.

* *See Procl. lib.*2.*cap.*3. & *Viturvius lib.*9.*cap.*3.

CHAP.

CHAP. XI.

Of GAUGING.

IN *GAUGING* there are two things chiefly necessary to be noted, yet both controverted. First, that seeing all manner of *Casks*, made to hold *Liquor* in, are for the most part the *Trunk* of a *Sphereroid*, cut off with two *Circles*, at *Rightangles* with the *Base*, and therefore *Irregular*, Therefore they must, first be reduced into a *Regular Proportion*. ——And the second thing necessary to be noted, is to find the true quantity of an *Ale*, or *Wine-Gallon* in *Cubick-Inches* or parts of a *Foot*, that thereby the Content of the *Vessel* or *Cask* in *Gallons* may be known.

SECT.

§. 1.

SECT. I.

Of Gauging any Beer, Ale, or Wine-Cask, also any manner of Brewers Tuns.

PROP. I.

To find the Solid Content in Inches of any Cask.

I Shall follow Mr. *Oughtred's* method, which is, Take the *Diameter* of the *Cask* both at *Head* and *Bung*, by which find the *Area's* of their *Circles*, which done, then take two thirds of the *Area* of the *Bung*, and one third of the *Area* at the *Head*, which added together, shall be the *Mean Area* of the *Cask*; which multiplyed into the length of the Vessel, it will shew how many *solid Inches* are contained therein.

Example: Suppose the *Diameter* at the Head of a *Vessel* be 18, and at the *Bung* 32, and length is 40 *Inches*.

Now I find the *Aggregate* of the two *Circles* to be 620, and 989, *Cubick Inches*: which multiplyed by 40, the length, produceth 24839, $\frac{56}{100}$ *Cubick Inches*, for the whole Content of that *Cask* in *Cubick Inches*.

PROP.

§. 1.

PROP. II.

To find the Content of a Vessel in Wine, or Ale Gallons.

The *Wine Gallon* is established by the Consent of *Artists*, in these and other Nations, to contain 231 *Cubick Inches* *. Yet Dr. *Wybard* affirms it to be somewhat less, to wit 225, at most: The *Ale Gallon* contains 282 *Cubick Inches*, according to the Establishment of *Excise*. Herein Artists differ somewhat in their Experiments.

* *See Mr.* Oughthred *in his Book of the Circles of Proportion, page the* 57. *and Mr.* Edm. Gunter *in his Book of the Cross-staff, part* 21. *chap. the* 4.

Now having already shewed how to find the Content in *Inches* of any *Cask*, I now come to shew how to find the Content in *Gallons*, of any *Beer*, *Ale*, or *Wine Cask*, which is thus: Divide the Number of Inches given by 231, for *Wine Measure*, and 282, for *Ale Measure*. In the former Example I find the said *Cask* to contain 107, 53 *Wine Gallons*, and 88, 8, *&c. Gallons* in *Ale Measure*.

PROP. III.

How to Gauge or Measure Brewers Tuns, &c.

Those Tuns are most commonly *Segments* of *Cones* or *Pyramid*, whose *Basis* is either a *Square Parallelogram*, *Circle*, or *Oval*; to measure which, let

let their form be what it will you must do thus. §. 1.
By the former Rules of Measuring such *Segments* or *Bodies*, you must find their Solid Content in *Cubick Inches*, (as in prop. 3. §. 2. chap. 10.) which Content divide by 282 Inches, (the *Inches* in one *Gallon*) it sheweth the Content in *Gallons*, and dividing the *Gallons* by 36, (the number of *Gallons* in a *Barrel*) it shews the Content in *Barrels*.

SECT. II.

§. 2.

Of Gauging or Measuring, and the Moulding of Ships.

PROP. I.

To Gauge a Ship, thereby to find how many Tuns her burthen is.

IN the *Gauging* or Measuring of *Ships*, *Naupegers*, or *Ship-Wrights*, observe these three Particular Rules: *First*, that if you measure the Ship within, you shall find the *Content*, or the *Burthen* the Ship will hold or take in. *Secondly*, if the Ship be measured on the outside, to her *light mark* as she swims being unladen, you shall have the Content of the *Empty Ship*. *Thirdly*, but if you measure from the *light mark*, to her *full draught of Water* being *laden*, you shall have the true *Burthen* of the Ship. Now

§. 2. Now to find the Content of the *King's Royal Ships*: Measure the length of the *Keel*, the breadth of the *Mid-ship Beam*, and the *depth of the Hold*: which three multiply into one another, and divide their *Product* by 100; so shall you find how many *Tuns* her *Burthen* is.

But for *Merchant's Ships*, which give no allowance for *Ordnance*, *Masts*, *Sails*, *Cables*, *Anchors*, &c. which are all a *Burthen*, but no *Tonnage*, you must divide the product by 95, so shall their true *Burthen* be found.

PROP. II.

By knowing the Measure of a Ship, of one Burthen, to make another Ship, of the same Mould, which shall be double, or triple, or in any proportion, either more or less than the said Ship.

First you shall multiply the *Keel Cubically*; and in like manner every *Beam*; the *Mid ship Beams* multiply them *Cubically*; and also the *Reaking* of the *Ship*, both at *Stem*, and *Stem-Post*, multiply them *Cubically*; likewise the *principal Timbers*, that doth *mould the Ship*, multiply them *Cubically*; and the *depth* of the *Hold*, multiply it *Cubically*; and so consequently every *Place*, or *Places*, which doth lead any work, multiply them *Cubically*; then if it be required to have a Ship as big again, or thrice as big; *double*, or *triple* each respective *Cubical number*; then by prop. 9. §. 1. chap. 1: Or by prop. 4. §. 2. chap. 2. find the *Cube-roots* thereunto belonging; then according unto these respective Numbers, make your *Keel*, your *Timbers*, *Beams*, &c. which being done, you shall make a Ship of the Mould and Proportion desired.

CHAP.

CHAP. XII.

Of DIALLING.

HOROLOGIOGRAPHIA, *or the Art of* DIALLING, *is an Art Mathematical, which demonstrateth the precise Distinction of Times, by the Sun, Moon and Stars, whereby the Time of the Day, or Night, may be known**. Now the Demonstrative delineation of *Dials*, consisteth chiefly in the finding out the *Hour-lines*, and their true distance one from the other: which lines are *great Circles* of a *Sphere*, which being projected on a *plain Superficies*, become streight-lines; which lines do continually vary, according as the *Planes* on which they are described, or projected, do lie situated in respect of the *Horizon* of the Place. Now

* *Which doth appear to have been in use above this 2400 Years, for King* Achaz *had a Dial: This Art requireth good skill in Geometry, and Astronomy:* Now Cresibius *that famous Philosopher measured the Hours and Times by the orderly running of Water. Then by Sand was the Hours measured. After that by* Trochilike *with Weights, and of late with* Trochilike *with Springs.*

Now a *Dial* may be made on any *Plain Superficies*, for all *Plain Superficies* are Posited either *Perpendicular*, *Parallel*, or *Oblique*, to the *Horizon* of the Place, in which the *Plane* is seated.

In the delineation of all which *Dials* in this Chapter described, (which are the most Eminent, and usefull Dials now used) I have used this Method: *First*, I have shewed how to delineate them by *Geometrical Projection*, by *Scale*, and *Compass* only: and *secondly* how they may be described by *Arithmetical Calculation*, of both which I have been very plain and large.

SECT. I.

§. 1. *Of the Delineation and Projection of sundry most usefull Dials.*

PROP. I.

How to draw the Hour-lines on an Equinoctial Plain.

AN *Equinoctial Plane*, is such which lieth *Parallel* unto the *Equinoctial*, and is an *Horizontal Plane*, under the *Pole*. This is the first and plainest kind of *Dials*, and is made after this manner: First describe the *Circle* Æ, W, E, R, for your Planes, then Cross it
Fig. 64. with the two *Diameters* EW, and ÆR. Then divide the *Semicircle* E, W, R, into 12 equal parts in the points ⊙, ⊙, ⊙, *&c.* Then from the *Center* Q, and through the said points draw

draw streight lines, which shall be the true *Hour-lines* belonging unto this *Equinoctial Plane*. Now because these *Planes* are capable of receiving all the *Hour-lines* from *Sun-rising* unto the *Sun-setting*, in *Summer*; therefore the *Hour-lines* of 4, and 5, in the *Morning*; and 7, and 8, in the *Evening*; must be delineated as you see done in the *Figure*: These Hours may be sub-divided into *half Hours*, and *Quarters*: The *Stile* of this *Dial*, must be a streight *Pin*, or *Wyre* set *Perpendicular*, to the *Plain*, on the *Center* Q. and of any convenient length. This Dial may be made for any Latitude, and is of good use for Seamen, and others. §. 1. Fig. 64.

PROP. II.

How to draw the Hour-lines on a Polar Plane.

A *Polar Plane* is one that lies *Parallel* unto the *Pole*, and under the *Equinoctial* is an *Horizontal Dial*: the way to make this Dial is thus. *First* draw the line AB, for the *Horizontal line* of the *Plane*; and cross it at the Middle at *right angles*, with the line 12, Q, 12, which is the *Meridian* or Hour line of 12; Then upon the line 12, Q 12, either above or below the point Q, assume any point as S, then setting one foot of your Compasses in S, describe the *Semicircle* CED, which divide into 12 Equal parts, in the points ☉, ☉, ☉, *&c.* Then lay a Ruler unto S, and unto the several points ☉, ☉, ☉, *&c.* and it will cross the line AB, in the points x, x, x, *&c.* Then through those points draw (by prop. 4. §. 1. chap. 4.) right lines all *Parallel* Fig. 65.

§ 1. unto 12 Q 12, and ſo is your Dial finiſhed. Then according unto the breadth of the *Plane*,

Fig. 65. you may proportion your *Stile*, *Whoſe height muſt be equal to the diſtance between the two Hour-lines 12, and 9, or 12, and 3, and then will the ſhadow of the upper edge thereof ſhew the Hour of the day: The height of the *Stile*, is alſo found thus.

* *Which may be either a* Pin *of the length of* Q S, *placed on* Q, *and* Perpendicular *unto the* Plane, *or it may be a* piece of braſs *or elſewhat of the breadth of* 12, *to* 3, *or* 9.

As the Tangent of the Hour-line 4 *or* 5,
To the Diſtance thereof from the Meridian.
So is the Radius,
To the Height of the Stile.

Then for the other *Hour-line*, ſay,

As the Radius,
To the Height of the Stile.
So is the Tangent of any other Hour-line,
To the Diſtance thereof from the Meridian line.

PROP. III.

How to draw the Hour-lines on a Meridian Plane, which is an Eaſt, or Weſt Dial.

A *Meridian Plane* ſtands upright directly in the *Meridian*, and hath two Faces, one towards the *Eaſt*, and the other towards the *Weſt*.

Now admit it be required to make a direct
Fig. 66. *Eaſt Dial*, in the *Latitude* of 51° 32′: let A, B, C, D, be a *Dial-plane*, on which you would deſcribe a *Direct Eaſt Dial*, on the point D, de-

ſcribe

ſcribe an *obſcure Arch* HG, with the *Radius* of your line of *Chords*, then take 38° 28′, the *Complement* of your *Latitude*, place it from G to L; then draw DL quite through the *Plane*; Then to proportion your *Stile* unto your *Plane*, ſo that all the Hours may be placed thereon, from *Sun-riſing* to 11 *a Clock*. Aſſume two points in the line LD, as K, for 11; and I for the 6 *a Clock* Hour lines; then draw 6, I 6, and 11, K 11, *Perpendicular* to LD. This done, with the *Radius* of your *line of Chords* on L, ſtrike the *Arch* OP, and from P, to O, place 15° 00′; and draw OK, to cut 6 I 6, in M, ſo ſhall IM be the height of the *Stile* proportioned unto this *Plane*; which may be a Plate of *Braſs*, whoſe breadth muſt be equal to the diſtance between the Hour-lines of 6, and 9, which muſt be placed *Perpendicular* to the *Plane*, on the line 6, I 6, whoſe ſhadow of the upper edge, ſhall ſhew the Hour of the day. Now to draw the Hour-lines, with the *Radius* of your *line of Chords*, on M ſtrike the *Arch* QN, which divide into 5 equal parts in the points ●, ●, ●, *&c.* Then lay a Ruler from M unto each of thoſe points, and it will cut the line IK in the points *, *, *, *&c.* through which points (by *prop.* 4. § 1. *chap.* 4.) draw Parallels to 6 I 6, as the lines 77, 88, *&c.* which ſhall be the true Hour-lines of an Eaſt *Plane*, from 6 in the Morning, till 11 before *Noon*. Then for the *Hour-lines* of 4, and 5, you muſt prick off 5 as far from 6, as 6 is from 7; and 4, as far as 6 is from 8; and draw the *Hour-lines* 55, and 44, as before Thus is your *Dial* compleated, and in the forming of which, you have

§. 11.

Fig. 66.

Fig. 66.

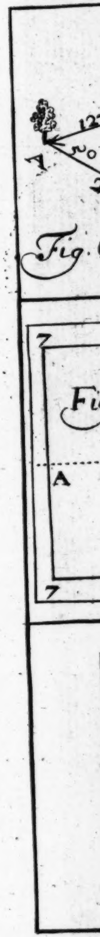
§. 1. made both an *East*, and a *West Dial* ; which is the same in all respects, only whereas the *Arch* H G, through which the *Equinoctial* passed in the *East Dial*, was described on the right hand of the *Plane*, in the *West* it must be drawn on the left hand, and the *Hour-lines* 4, 5, 6, 7, 8, 9, 10, and 11, in the *Forenoon* in the *East Dial*,
Fig. 67. must be 8, 7, 6, 5, 4, 3, 2, and 1, in the *West* in the *Afternoon* ; as in the *Figure* plainly appeareth : Now you may find the distance of the *Hour-lines* from the *Substile*, by this *Analogy* or *Proportion*.

As the Radius,
To the Height of the Stile.
So is the Tangent of any Hours distance from 6,
To the distance thereof from the Substile.

PROP. IV.

How to draw the Hour-lines on a direct South, and North Plane,

This *Plane* or *Dial* must stand upright, having his face or *Plane*, if it be a *South Dial*, directly opposite unto the *South* ; but if a *North Plane*, directly opposite unto the *North* ; now
Fig. 68. admit it be required to make a *Direct South Dial*, for the *Latitude* of 51° 32′ : To make which first describe the *Circle* ABCD, to represent an *Erect direct South Plane*, cross it with the *Diameters* CB, and AD, then out of your *Line of Chords* take 38° 28′, the *Complement* of the *Latitude*, and set it from A, unto a, and from B, unto b, Then lay a Ruler from C unto a, and it will cut the *Meridian* ARD, in P, the *Poles* of the



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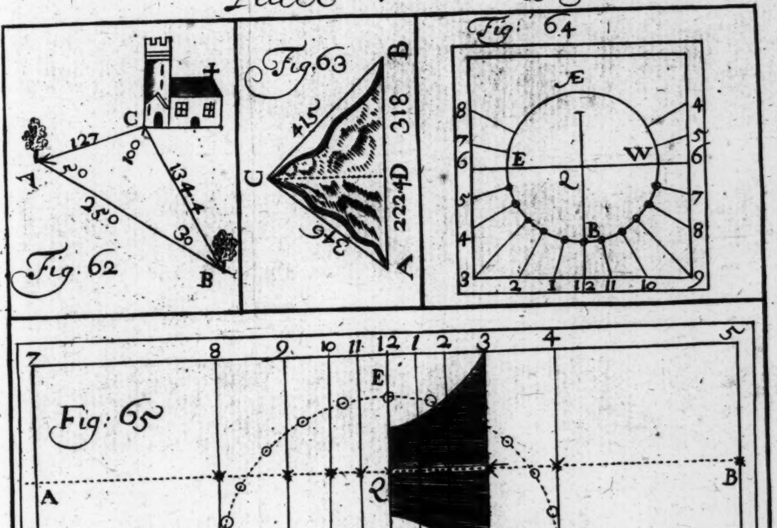


the *World*, a Ruler alſo laid from C, to b, will cut the *Meridian* ARD, in Æ, which is the point through which the *Equinoctial* muſt paſs; for the drawing of which you have three points given: *viz.* C, Æ, and B, and the *Center* will always be in the *Meridian line* ARD: To find the *Center* thereof do thus: Draw BÆ, and divide it equally in K, erect KM *Perpendicular* to ÆB (by prop. 1. §. 1. chap 4.) and continue it until it cutteth the line MAR, in M, ſo is M, the Center of the *Equinoctial Circle* CÆB, which deſcribe, then divide it into 12 equal parts, in the points ●, ●, ●, *&c.* the *Semicircle* CDB, then lay a *Ruler* unto R, and to each of thoſe points, and it will croſs the *Equinoctial Circle* CÆB, in the points *, *, *, *&c.* dividing that into 12 unequal parts, then lay a *Ruler* from P, and to every of thoſe points and it will croſs the *Circle* of the *Plane* CDB, in the points J, J, J, *&c.* Laſtly, draw from the Center R, and through thoſe points the right lines, which ſhall be the true *Hour-lines*, of an *Erect direct South Dial*. Now for the *Stile* take 33° 28′, the *Complement* of the *Latitude*, and place it from D unto e, and draw R e, for the *Axis* of the *Stile*, which muſt hang directly over the *Hour-line* of 12, or the *Meridian*, and muſt point downward, towards the *South Pole*, becauſe the *Plane* beholdeth the *South* part of the *Meridian*.

§. 1.

Fig. 68.

Now in making this *Erect direct South Dial*, you have alſo made an *Erect direct North Dial*, which is but the backſide of the *South Dial*, lying in the ſame *prime Vertical*; only as this hath the *South Pole Elevated* above it, and beholdeth the *South* part of the *Meridian*, ſo the other

Fig. 69.

§. 1. other hath the *North Pole* of the *World* elevated above it, and beholdeth the *North part* of the *Meridian*. The *Hour-lines* of 9, 10, 11, or 1, 2, and 3, is not expressed on this *Plane*, because 12, representeth 12, at *Midnight*; neither are the other said Hours expressed, because the *Sun* is never above the *Horizon*, at those Hours;
Fig. 69. Therefore the *North Dial* is capable only to receive these *Hours*, namely 4, 5, 6, 7, and 8, in the *Morning*; and 4, 5, 6, 7, and 8, at *Night*; as doth plainly appear in the Figure: Now the distance of the *Hour-lines* from the *Meridian*, may be found by this *Analogy*, or *Proportion*.

As Radius or S. 90°,
To Sc. *of the Latitude.*
So is T. *of the Hour from Noon,*
To T. *of the Hour-line from the Meridian.*

PROP. V.

How to draw the Hour-lines on an Horizontal Plane.

This *Horizontal Plane*, or *Dial*, is one of the best and most usefull *Dials* in our *Oblique Hemisphere*: Admit it be required to make an *Horizontal Dial*, for the *Latitude* of 51° 32′:
Fig. 70. To make which, first describe the Circle AB CD, which representeth your *Horizontal Plane*, Then cross it with the two *Diameters* ARC, and BRD, Then take 51° 32′ out of your *Line of Chords*, and set it from B, to a, and from C, to b, Then lay a *Ruler* from A, unto a, and it will cut the *Meridian* BD, in P, the *Pole* of the *World*,

World, Then lay a *Ruler* from A, unto b, and it will cut ABD the *Meridian*, in the point Æ, where the *Equinoctial* cutteth the *Meridian*, then through the three points A, Æ, and C, draw the *Equinoctial Circle*, whose Center is at H; (and found as in the former proposition) Then divide the *Semicircle* ADC into 12 equal parts, in the points ●, ●, ●, *&c.* Then lay a *Ruler* to R the *Center* of the *Plane*, and on those points, so shall the *Equinoctial Circle* AÆC, be by it divided into 12 unequal parts in the points ✳, ✳, ✳, ✳, *&c.* Then a *Ruler* laid unto P the *Pole* of the *World*, and those Points, shall cut the *Semicircle* CDA in those Points J, J, J, *&c.* Lastly, from the *Center* R, and through those Points, let there be drawn right lines, which shall be the true *Hour-lines* of such an *Horizontal Plane*, from 6 in the Morning, untill 6 at Night; but for the Hours of 4 and 5 in the Morning; and 7 and 8 in the Evening; they are delineated by producing 4 and 5 in the Evening, through the *Center* R, and 7 and 8 in the Morning; extending them out, unto the other side of the *Plane*, so shall you have those *Hour-lines* also on your *Plane* delineated as you see in the *Figure*. The *Stile* of this *Plane* may be a thin Plate of *Brass*, cut exactly unto the Quantity of an Angle of 51° 32′, and set *Perpendicular* on the *Meridian line*, for the forming of this *Stile* take out of your *Line of Chords* 51° 32′, and set it from D, unto e, and draw Re, which shall be the *Axis* of the *Stile*, you may also prefix the *Halves*, and *Quarters* of *Hours*, in the very same manner as the *Hours* themselves were drawn

§. 1.

Fig. 70.

Fig. 70.

§. 1. Now to find out the distance of the *Hour-lines* from the *Meridian*, say,

As the Radius or S. 90°,
To the S. *of the Latitude.*
So is the T. *of the Hour from Noon,*
To the T. *of the Hour-line, from the Meridian Line.*

Fig. 70. These kinds of *Dials* being so frequently used with us, in this *Oblique Sphere*, for the help of the speedy delineating of them, I have annexed hereunto the Table of *Longomontanus*, wherein the *Hour-lines*, for many *Latitudes*, are calculated.

A Table

§. 1.

A Table shewing the Distance of the Hour-lines from the Meridian, in these Degrees of Latitude.

The Hours from the Meridian.

An Horizontal Dial, Latitude.	xi.	i.	x.	ii.	ix.	iii	viii.	iv.	vii.	v.	vi.		A South Erect Dial, Latitude.
	D	M	D	M	D	M	D	M	D	M	D	M	
30	7	38	16	6	26	34	40	54	61	49	90	00	60
31	7	51	16	34	27	14	41	42	62	28	90	00	59
32	8	4	17	1	27	53	42	30	63	6	90	00	58
33	8	17	17	27	28	34	43	17	63	45	90	00	57
34	8	30	17	54	29	13	44	5	64	42	90	00	56
35	8	43	18	20	29	49	44	46	64	56	90	00	55
36	8	56	18	45	30	25	45	28	65	27	90	00	54
37	9	9	19	9	31	1	46	9	65	58	90	00	53
38	9	21	19	34	31	37	46	50	66	29	90	00	52
39	9	33	19	57	32	9	47	26	66	55	90	00	51
40	9	46	20	20	32	40	48	1	67	20	90	00	50
41	9	58	20	43	33	14	48	37	67	45	90	00	49
42	10	10	21	7	33	47	49	13	68	11	90	00	48
43	10	22	21	29	34	17	49	44	68	32	90	00	47
44	10	24	21	50	34	46	50	14	68	52	90	00	46
45	10	43	22	12	35	15	50	45	69	14	90	00	45
46	10	54	22	33	35	44	51	16	69	37	90	00	44
47	11	5	22	33	36	10	51	43	69	53	90	00	43
48	11	16	23	12	36	35	52	9	70	10	90	00	42
49	11	26	23	32	37	1	52	35	70	28	90	00	41
50	11	36	23	51	37	27	53	1	70	43	90	00	40
51	11	46	24	9	37	50	53	24	70	58	90	00	39
52	11	56	24	26	38	13	53	46	71	12	90	00	38
53	12	5	24	44	38	36	54	8	71	27	90	00	37
54	12	14	25	2	38	59	54	30	71	41	90	00	36
55	12	23	25	18	39	18	54	50	71	53	90	00	35
56	12	32	25	33	39	38	55	9	72	4	90	00	34
57	12	46	25	49	39	58	55	28	72	16	90	00	33
58	12	48	26	5	40	18	55	46	72	27	90	00	32
59	13	56	26	19	40	36	56	1	72	38	90	00	31
60	13	58	26	30	40	53	56	15	72	47	90	00	30

§. 1.

PROP. VI.

How to draw the Hour-lines, on an Erect declining Plane.

These *Planes* are made to ſet on the ſides of Fig. 71. *Houſes*, wherein the *Meridian* is always a *Perpendicular*, drawn on the *Plane*, in whoſe top is the *Center*, where the *Subſtile*, and the *Hour-lines* all meet.

Now before we can delineate the *Hour-lines* on any ſuch *Planes*, two things muſt be given; *As the Latitude of the Place*, and *the Planes Declination*; by having which we muſt find theſe three things: *viz. The Poles height above the Plane. The diſtance of the ſubſtile from the Meridian. And the Plane's difference of Longitude.*

For the finding of which *Requiſites*, by *Geometrical Projection*, we deſcribe on the *Dial Plane*, theſe Circles of the *Sphere*, *viz.* The *Horizon*, *Meridian*, and *Equinoctial*, which being deſcribed in their true Poſition, on the Fig. 71. *Plane*, we proceed thus.

Admit it be required to make a *Direct South Dial*, on an *Erect*, *Direct South Plane*, *Declining Weſtward* 24° 20′, in the *Latitude* of 51° 32′.

Now in order to find the requiſites before mentioned, deſcribe the *Circle* ZHNO, and croſs it with the two *Diameters* ZQN, and HQO: now Z is the *Zenith*, N the *Nadir*, ZQN the *Hour-line* of 12, HQO the *Horizon*. Now ſeeing the *Plane* declines S. W. 34° 20′: make N a, and O b, each equal to 34 20: Then a *Ruler* layed from Z, to a, will cut the *Horizon* in S, the South

South point of the *Horizon*, through which draw the *Meridian* ZSN, whose Center is at Y, found as in the fourth Proposition aforegoing: Then a Ruler laid from Z to b, will cut the *Horizon* in W, the West point thereof. Now the *Horizon* and the *Meridian* being projected on the *Plane*, take out of your line of *Chords* 51° 32′, which place from H, unto c, and from N, unto d; then lay a Ruler from W, unto c, and it cutteth the *Meridian* in P, the *Pole* of the *World*. Then through P and Q, draw the line PQD, which representeth the *Axis* of the *World*, and the *Substilar line* of the *Dial*, then lay a Ruler from W, to d, it cutteth the *Meridian* in Æ, so is WÆ two points through which the *Equinoctial* must pass, whose *Center* is found as afore to be at M, (being always in the *Axis* of the *World*) so have you on your Plane the *Horizon* HQO, the *Meridian* ZPSÆ N, and the *Equinoctial* LÆKWG, described on the *Plane* as required. § 1. Fig. 71.

Now *first* to find the *Poles height above the Plane*, which in this *Scheme* is represented by BP, Lay a Ruler from G, unto P, and it shall cut the *Plane* in V, then measure the distance BV, on your line of *Chords*, and you will find it to contain 34° 33′, which is the *Poles height above the Plane*. Fig. 71.

Secondly, To find *the distance of the Substile from the Meridian* represented in the *Scheme* by the *Arch* ZB, or ND, which measured as afore will appear to be 18° 08′, the distance of the *Substile* from the *Meridian*.

Thirdly, To find *the Plane's Difference of Longitude*, which in the *Scheme* is represented by the

§. 1. the *Angle* ÆPK, lay a Ruler from P, unto Æ, and it cutteth the *Plane* in X, then measure the *Arch* DX, as afore, and so will you find the *Planes Difference of Longitude*, to be 30° 00′:

Fig. 71. Thus by *Geometrical Projection* have we found all the three *Requisites*: Now to find them by *Arithmetical Calculation* observe these *Analogies* or *Proportions*.

1. *For the Poles height above the Plane*, say,
As Radius or S. 90°,
To Sc. *of the Latitude* 38° 28′.
So is Sc. *of the Declination* 65° 40′,
To S. *of the Poles height above the Plane* 34° 33′.

2. *For the Distance of the Substile, from the Meridian*, say,
As the Radius or S. 90° 00′,
To the S. *of the Plane's Declination* 24° 20′.
So is Tc. *of the Latitude* 38° 28′,
To the T. *of the Substilar Distance from the Meridian* 18° 10′.

3. *For the Plane's Difference of Longitude*, say,
Fig. 71. *As the* Sc. *of the Latitude* 38° 28′,
To the Radius or S. 90° 00′.
So is S. *of the Substilar Distance* 18° 10′,
To the S. *of the Difference of Longitude* 30 *Deg.*

Or, it may be found thus.
As the S. *of the Latitude*,
To the Radius.
So is the T. *of the Declination*,
To the T. *of the Difference of Longitude* required.

These

These things found, we come now to shew how the *Hour-lines* may be projected. To project which observe, First, to lay a Ruler from P the *Pole* of the *World*, to Æ the *Intersection* of the *Equinoctial* with the *Meridian*, and it will cut the *Plane* in x, where begin to divide the *Semicircle* L x G, into 12 Equal parts in the Points ●, ●, ●, ●, *&c.* Then lay a Ruler from Q, to every of those parts, and it shall cut the *Equinoctial*; and divide it into 12 unequal parts, in the points ✳, ✳, ✳, ✳, *&c.* Then a Ruler laid from P the *Pole* of the *World* unto each of these points, it will divide the *Plane* into 12 unequal parts in the Points Ɉ, Ɉ, Ɉ, Ɉ, *&c.* Then by a Ruler laid from the *Center* Q, to those points, draw right lines, which shall be the *true Hour-lines* proper unto such a *Declining Plane*, as you see plainly demonstrated by the *Scheme*. §. 1. Fig. 71.

Now the *Substilar line* falleth in this *Dial*, just on the *Hour-line* of 2, in the Afternoon, because the *Plane* declineth *Westerly*. The *Angle* of the *Stile* is DQR 34° 33'. which may be either a *Plate* or *Wyre*, brought into such an *Angle*, which must be placed *Perpendicular* to the *Plane*, and directly over the *Substilar line* QD 2.

Now the distance of the *Hour-lines*, from the *Substilar line*, may also be found by this *Analogy* or *Proportion*.

As the Radius, Fig. 71.
To the S. *height of the Pole above the Plane.*
So is the T. *of the Hour-line from the Meridian of the Plane,*
To the T. *of the Hour-line from the Substile.*

Thus

§. 1. Thus have you compleated your *Dial*, as you ſee in the *Scheme*, and here you may take notice that having finiſhed a *Weſt Decliner*, you have alſo made an *Eaſt Decliner*; if you only convert the *Hour-lines* of the *Weſt Decliner*, in ſuch manner as you ſee in *Fig*. 72. on the *Eaſt Decliner*, and compleat all as you ſee in that *Scheme*.

Fig. 72.

Thus I have explained the making and delineating of the beſt and moſt uſefull *Dials* both by *Geometrical Projection*, and alſo by *Arithmetical Calculations*, in as brief and compendious a manner as poſſible. There are ſundry other kind of *Dials*, as *Incliners*, *Decliners*, and *Recliners*, which being not ſo uſefull, for brevity ſake, they are here omitted: As for *Inſtrumental Dials*, as *Quadrants*, *Rings*, *Cylinders*, *&c*. Which depend on the Sun's height, I refer you to Mr. *Edm. Gunter's* Book, wherein *they* are largely deſcribed.

As for the Beautifying and Adorning of thoſe *Dials*, &c. by deſcribing on them the *Equinoctial*, *Tropicks*, *Parallels of Declination*, *Parallels of the Sun's Place*, *Length of Days*, *the Sun's Riſing* and *Setting*, *Jewiſh*, *Italian*, and *Babyloniſh Hours*, *Almicanthars*, *Azimuths*, *Circles of Poſition*, the *Signs Right Aſcending*, *Deſcending*, *Culminating*, &c. I do adviſe you to conſult Mr. *Gunter*, Mr. *Foſter*, Mr. *Wells*, and Mr. *Holwel's Works*, all which Authors have very learnedly ſhewed the deſcribing of them, by ſeveral large *Schemes*, and *Figures*, for the plainer Illuſtration thereof.

Now ſeeing the *Latitude* of a Place muſt be firſt known, before a *Dial* can be made to it,

I have

Plate V

Fig: 68

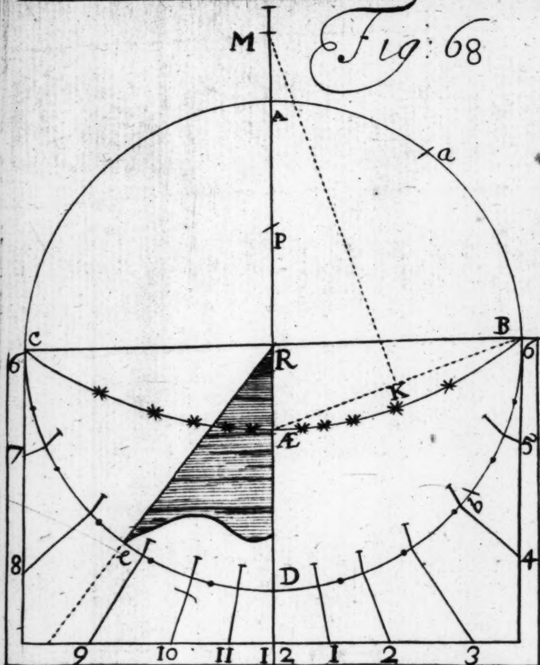


Fig: 69

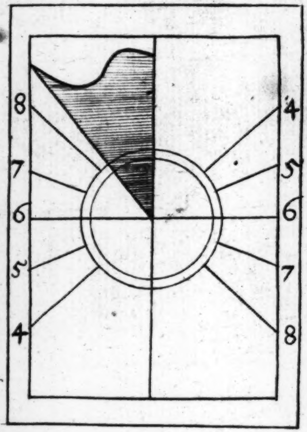


Fig: 71

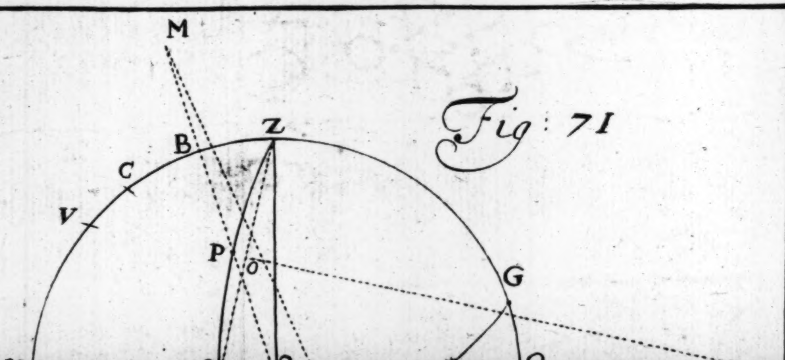


Figure 70

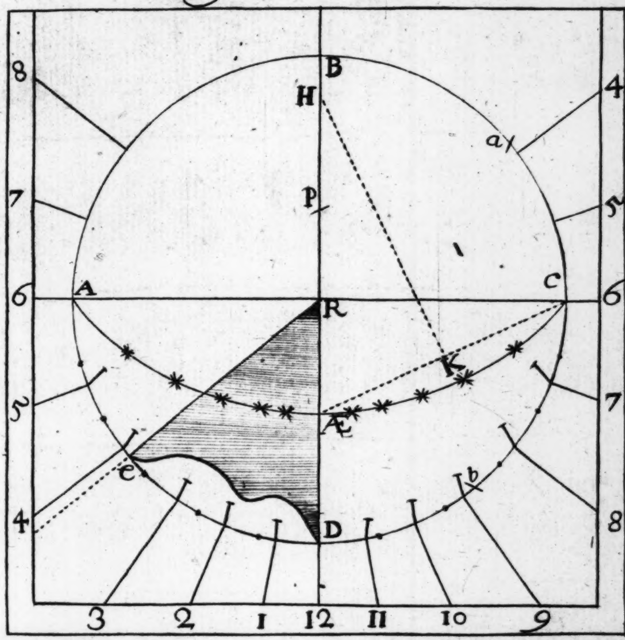
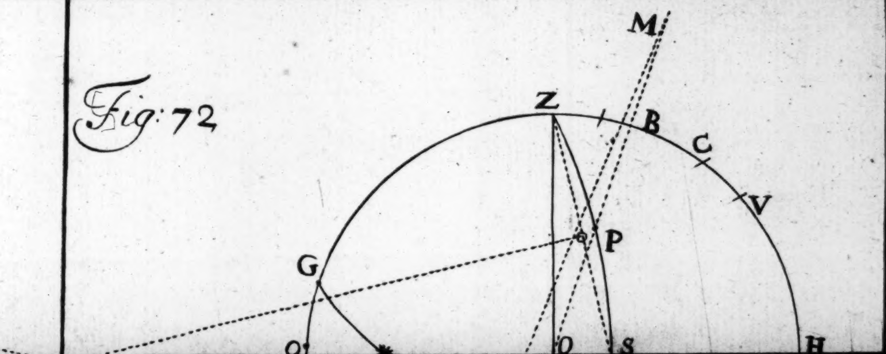
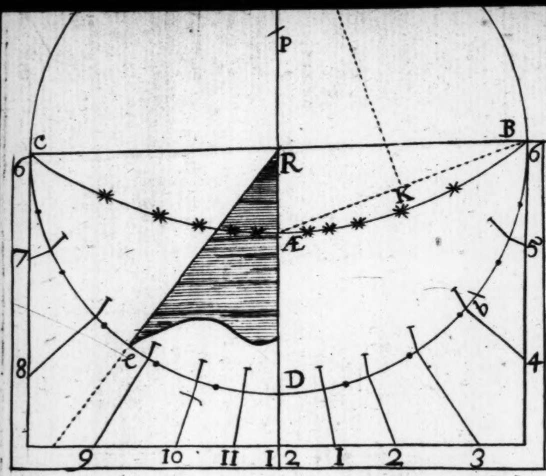


Fig: 72

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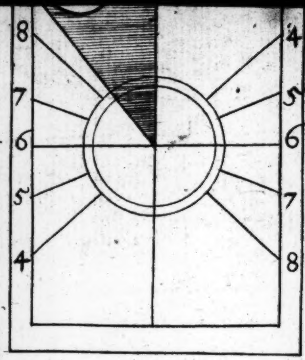
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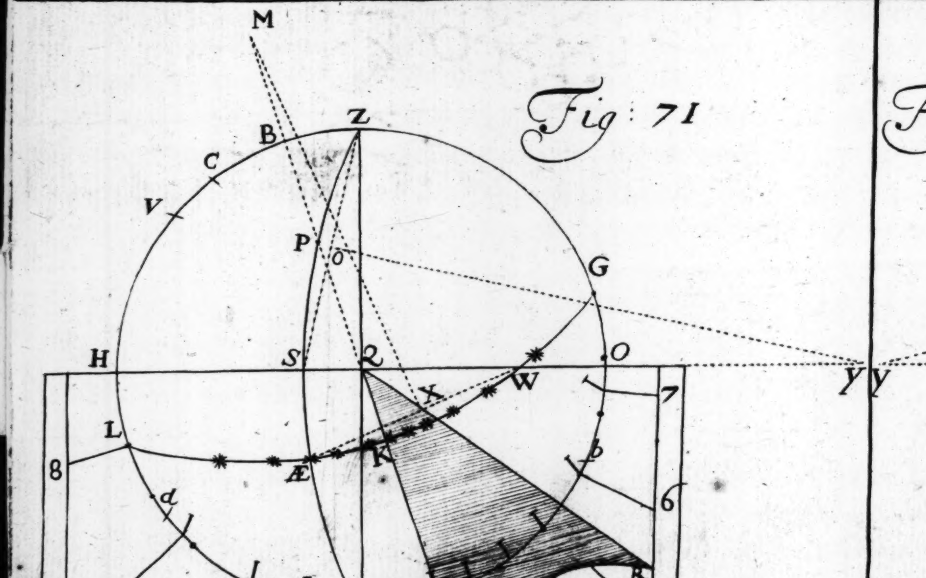
Fig: 71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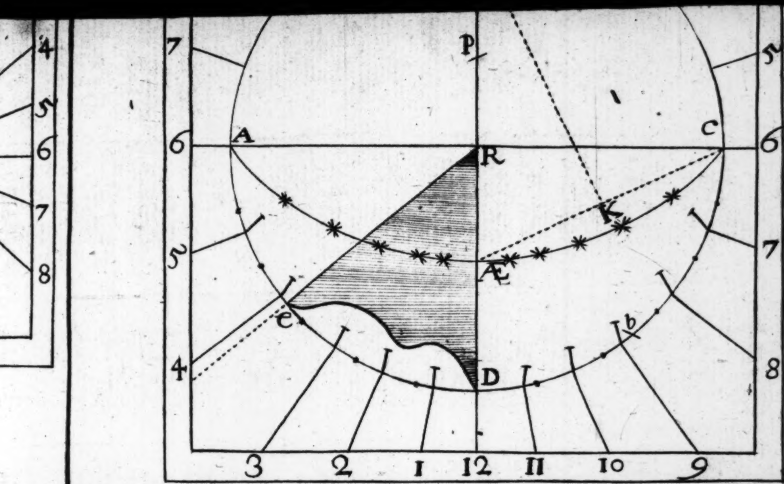
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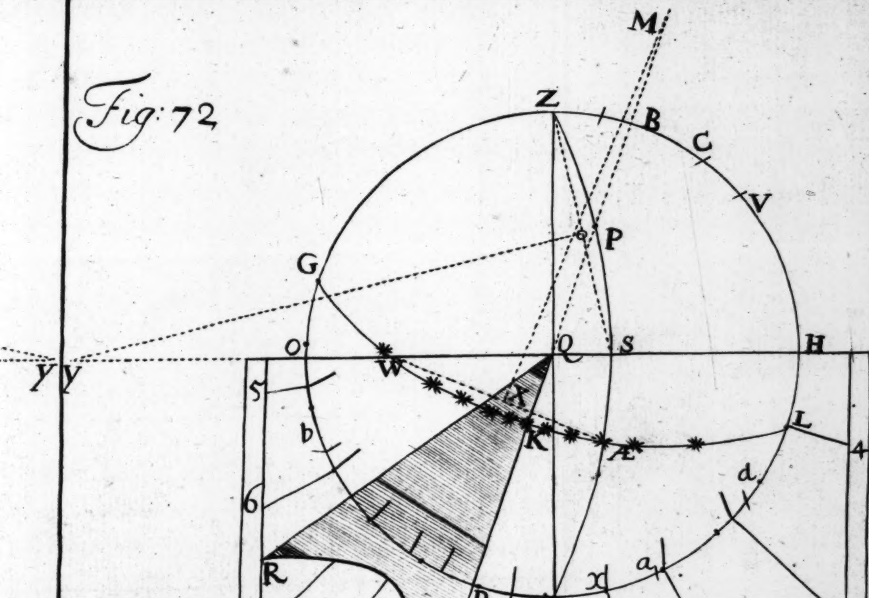
Fig: 72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I have therefore hereunto annexed a Table of the *Latitudes* of all the principal *Cities*, *Towns*, and *Islands*, in and about *Great Britain* and *Ireland*; so that if you are to make a *Dial*, for any of those parts, you may have recourse to this Table, and make your *Dial* to the Latitude of that place, which you find to be the nearest to the Place, for which you are to make your *Dial*. §. 1.

A Table of the Names and Latitudes of all the Principal Cities, Towns, and Islands, in and about Great Britain *and* Ireland.

ENGLAND.

	D.	M.		D.	M.
Arundel	51	00	*Falmouth*	55	22
A. Bedford	52	15	*Glocester*	51	57
Barwick	55	54	*Guilford*	51	12
Bristol	51	35	*Hartford*	51	54
Buckingham	52	10	*Hereford*	52	17
Cambridge	52	20	*Huntington*	52	30
Canterbury	51	25	*Ipswich*	52	20
Carlisle	55	20	*London*	51	30
Chichester	50	48	*Lincoln*	53	20
Chester	53	18	*Leicester*	52	45
Colchester	52	08	*Lancaster*	54	15
Dover	51	20	*Northampton*	52	24
Derby	53	00	*Norwich*	52	45
Dorchester	50	50	*Nottingham*	53	00
Durham	54	56	*Newcastle*	55	12
Exeter	50	48	*Oxford*	51	50
			Portsmouth	51	08
			Plimouth	50	36
			Reding	51	40

Salsbury

4. 1.

	D.	M.
Salsbury	51	12
Stafford	52	50
Stanford	54	44
Shrewsbury	52	50
Truero	50	30
Winchester	51	03
Worcester	52	25
Warwick	52	30
York	54	00

WALES.	D.	M.
Anglesey.	53	28
Barmonth	52	50
Brecknock	52	01
Cardigan	52	12
Caermarthen	51	56
Carnarvan	53	16
Denbigh	53	13
Flint	53	17
Landaffe	51	35
Monmouth	51	51
Montgomery	51	56
Pembroke	51	46
Radnor	52	19
St. *David*	52	00

SCOTLAND.	D.	M.
Aberdeen	57	30
Dunblain	56	21
Dunkel	56	48
Edenbrough	56	00
Glascow	55	58
Kinsaile	57	44
Orkney	60	06

	D.	M.
St. *Andrews*	56	40
Skyrassin	58	38
Sterling	56	12

IRELAND.	D.	M.
Antrim	54	38
Arglas	54	10
Armagh	54	14
Carterlagh	52	41
Clare	52	34
Corke	51	55
Droghedagh	53	58
Dublin	53	55
Dundalke	53	52
Galloway	53	02
Kenney	52	30
Kildare	53	00
Kings Town	53	08
Knockferguns	54	40
Kynsale	51	41
Lymerick	52	30
Queens Town	52	52
Waterford	52	09
Wexford	52	18
Youhall	51	53

ISLANDS.	D.	M.
Wight	50	48
Portland	50	30
Man	54	24
Limdey	51	22
Jerzey	49	12
Garnzey	49	03

CHAP.

CHAP. XIII.

Of FORTIFICATION.

THE *Utility of this Mathematical Art called Fortification, or Military Architecture, is ſo well known, that it needs not my commendation, and therefore to ſpeak any thing thereto, were but to light a Candle before the Sun.*

In the handling of this part of the *Mathematicks*, I ſhall be as brief as poſſible, yet as plain as can be deſired: In the proſecution of which, I ſhall uſe this Method. As *Firſt*, I ſhall give you the moſt principal *Definitions* or *Terms* belonging to this Art. *Secondly*, I ſhall preſcribe the moſt conducing *Maxims* or Rules herein obſerved. *Thirdly*, I ſhall ſhew how to delineate the Ground-line of any *Fortification*, according to the ſeveral Proportions, uſed by the beſt and moſt experienc'd Inginiers of *Italy*, *France*, *Holland* and *England*; *Fourthly*, I ſhall deſcribe the Conſtruction of the chief and principal Outworks now in uſe; and *Laſtly*, lay down ſome general *Maxims* or *Rules*, by moſt *Modern Authors* obſerved in *Irregular Fortifications*.

SECT. I.

§. 1. *Of the Definitions of the Lines, and Angles, belonging to the Principal Ground-work of any Regular Fortification.*

Defin. 1. THE *Exterior* or outward Line, which boundeth the *Rampart*, at the Foot next the *Ditch*, is the principal and only Line to be regarded in all *Regular*, or *Irregular Fortifications*, being the *Basis* on which all the other Lines, and parts of the *Fortification* doth depend.

2. The *Exterior Polygon*, is the outward side of any *Regular Figure*, as in the *Hexagon* (which Figure I shall make use of through this Tract) the side AA, is the *Exterior Polygon*.

Fig. 73. 3. The *Interior Polygon*, is the inward side of any Regular Figure, as in the *Hexagon* is noted by any of the sides between P and P.

4. The *Bastion* or *Bulwork*, is that great work of any *Fort*, that advanceth its self towards the *Campaigne*, and here are six all marked with B, the lines which terminate them, are two *Gorges*, two *Flanks*, and two *Faces*.

Fig. 73. 5. The *Demi-Gorge* or *Gorge*-line PC, is half the Entrance into the *Bastion*, and terminates the point C, whereby the *Flank* shall be raised.

6. The *Flank* is another Out-line of the *Bastion* as CF, which terminateth the *Curtain*, and *Face*.

7. The

7. The *Face* is the utmost line of the *Bastion*, as FA, two lines thereof doth form the Angle of the *Bastion* A, or the *Flanked Angle*. §. I.

8. The line forming the *Flank* FF, is a prick-ed line, made use of by the *Dutch Inginiers*, and others.

9. The *Capital* is AP, part of the line com-ing from the Center ⊙, terminated at the point of the *Bastion* A. Fig. 73.

10. The *Curtain* is that part of the *Interior Polygon* CC, which lieth betwixt the two *Basti-ons* B, and B.

11. The line of *Defence* is AC, passing from A, the point of the *Ba-stion*, to C the *Angle* of the *Flank*, and *Curtain*, and ought never to ex-ceed 800 English Feet *. Fig. 73.

* *Because the length of the part of a Musket doth not much exceed that Measure.*

12. The line *Stringent*, is the line coming from the point of the *Bastion* A, and prolonged on the *Face* AF, to the *Curtain* D, which shew-eth that DC, the part of the *Curtain*, (by some called the *second Flank*) will scour the *Face*.

13. The *Diameter* of the *Interior Polygon*, is the line ⊙P, coming from the Center thereof ⊙.

14. The shortest line from the Center unto the *Curtain*, is ⊙ m. These are the *Definitions* of the principal lines, appertaining to the Ground-work of any *Regular Fortification*, the *Angles* followeth.

15. The Angle of the *Center* of the *Polygon* is P⊙P. Fig. 73.

16. The *Angle* of the *Polygon* PPP, is always the *Complement* of the Angle at the Center, or remainer unto 180 *Degrees*.

§ 1. 17. The Angle of the *Triangle* PPO is always the one half of the *Angle* of the *Polygon* PPP.

18. The Angle of the *Bastion*, or the *Flanked*
Fig. 73. Angle FAF, is exposed unto the *Batteries* of the *Besiegers*, and formed by the two *Faces*, FA, and FA, which ought never to be less than 60, nor much above 100 *Degrees*.

19. The Angle of the *Espaule*, or Shoulder, is formed by the *Face*, and *Flank*, as AFC.

20 The Angle of the *Flank* CCF, is formed by the *Curtain*, and the *Flank*, and is most commonly a *Right Angle*, but by some later *Inginiers*, is made *Obtuse*, or more than a *Right Angle*, or 90 *Degrees*.

21. The Angle made by the two lines *Sitchant*, A t A is called the Angle of the *Tenaile*.

22. The Angle forming the *Flank*, is CPF, which Angle is made use of by most of the *Dutch*
Fig. 73. *Inginiers*.

SECT. II.

§. 2. *Of General Maxims or Rules observed in Fortifications.*

1. THat all the parts of the Place, be of *Cannon* Proof flanked, *i. e.* defended from another place, which place is no farther distant

distant than the reach of a *Musket-shoot*, from the place to be *Flanked* or defended *. §. 2.

* *Because the Defence ought to be easie, quick, certain, and of little charge, all which qualities the Musket hath and the Cannon hath not, therefore the Defence of Fortification ought to be measured by the Port of a Musket, and not by that of a Cannon.*

2. That in all the Place, there may be no part of the *Wall*, or outside of the *Rampire*, that is not seen from the top to the bottome of the *Mote*, or *Ditch.*

3. That the *Bastions* are large, and full of Earth, and not empty; the bigger they are, they are the more to be esteemed, there being the more room to intrench, in case of necessity: whose *Gorge* let be at least 35 *fadoms*, and their Flank at least 18 *fadoms.*

4. That the Angle of the *Bastion*, or *Flanked Angle*, be not much above 90, nor much less than 60 Degrees, for in the former it would lie too very *Obtuse*, and open, at the Point; and in the latter it would be too slender, and so easily to be battered down, by the Enemies *Cannon.*

5. That the Angle of the *Flank* may be somewhat *Obtuse*; neither is there any more virtue in a *Right-angle*, than in any other, for the defence of the *Fort.*

6. That the length of an extended *Curtain* be not above 135 *Fadoms*, nor the single above 80 *Fadoms*, nor be less than 40 *Fadoms*, to be well defended from two *Flanks.*

§. 2. 7. That the *Rampire* be so wide, that so a *Parapet* of Earth *Cannon proof* may be erected thereon, and a *Teraplane* left, full wide for the *Ordnance* to be *recoiled*.

8. That the *Mote* or *Ditch* be at least 20 *Fadoms* broad, and as deep as possible. Now dry *Motes* in great Cities are to be preferred before others, that are full of Water, to facilitate the *Sallies*, the relief, and retreat of the *Besieged*; and in small *Fortifications* the *Motes* full of Water are the most Esteemable, because in such Sallies are not necessary, and Surprises are very much to be feared.

9. that the Parts that are most remote from the *Center*, be commanded by those which are nearest to it.

10. That the Defence of a *Face* is much stronger, when the Angle made by the *Face*, and *Exterior Polygon* is a great Angle; this *Maxim* is so very essential, that it will try the goodness of any *Fortification* whatsoever: Thus I have described the 10 chiefest *Maxims*, necessary for good *Fortifications*.

SECT.

SECT. III.

Of the Construction and making of the principal Ground-line of a Fort, according to the most Modern ways, used by the Italian, Dutch, French, *or* English Ingi- niers. §. 3.

I. *Of the* Italian *Fortifications.*

GEnnaro Maria, *Mathematician* to the *Catholick King*, wrote at *Florence*, his *Elements* of *Military Architecture* entituled, *Breve Trattato delle Moderne Fortificazioni.* This *Italian* Author was a very Learned and Skilfull *Mathematician*, and famous in his Nation. In his said Book Printed 1665, he makes the *Interior Polygon* 800, and not less than 600 Feet, his *Demi-Gorge*, he makes $\frac{1}{8}$ of it, and so for the *Flank* of the *Quadrangle*. But for the *Pentagon*, and all Figures above, he makes the *Flanks* $\frac{1}{10}$ part of the *Gorge* more, and he placeth his *Flank* at *Right Angles* with the *Curtain*.

Supposing his *Interior Polygon* 1000 parts, his *Gorges* will be 125, and in the *Quadrangle* the *Flanks* will be 125, but of the *Pentagon*, and all above, 138 parts. For the *Faces*, he makes them to fall on the third part of the *Curtain*, unless in the *Square*, which he allows no *second Flank*.

§. 3.

PROP. I.

To fortifie a Hexagon according to this Author's Proportion.

Fig. 74. First describe the *Hexagon* PPP, *&c*, then divide the *Interior Polygon* PP, into 1000 equal parts, take 125 for the *Gorges*, and set it from P to C. Then on C raise a *Perpendicular*, make it equal to 138 parts, for your *Flanks* CF, then draw the *Face* AF, falling on the third part of the *Curtain* CC, at D, and so do on every *Bastion*, untill the work is compleated.

II. *Of the* French *Fortifications*.

Monsieur De la Mont, in his Fortifications *Offensive*, and *Defensive*, printed 1671: And *Monsieur Manesson Mallet* in his late work, intituled *Travaux de Mars*, printed 1672, assigneth these proportions for the laying down the Ground-line of a *Fort*.

Both these Authors make the *Interior Polygon* 768 English Feet, which they divide into 5 parts, and taking one for the *Gorge* $153\frac{1}{2}$ Feet. Both divides it into 3 parts, and takes one for the *Capital*, that is 256 Feet.

Fig. 74. Now our first Author *De la Mont*, makes the *Flank* to stand at *Right-angles* and takes $115\frac{1}{2}$ Feet for it, which is $\frac{1}{4}$ of the *Curtain*, and so draws the *Bastions*, in all save the *Quadrangle*, and *Pentagon*, which he makes to have no *second Flank*.

PROP.

§. 3.

PROP. II.

To fortifie a Hexagon according to the Proportion of De la Mont.

First describe your *Hexagon* P, P, P, *&c.* Now supposing your *Interior Polygon* PP, 1000 parts, the *Capital* 333, the *Gorge* 200, and the *Flank* 150 parts, take out of your *Triangular Scale* Fig. 75, (which is made for the more speedy delineation according to this proportion of *De la Mont*) PA for the *Capital*, and prick it off from PA, on all the *Bastions*. Then take PC, and prick off all the *Gorges* from P to C. Then take FC and prick it off at *Right Angles*, from C to F. Lastly draw all the *Faces* AF, AF, *&c.* so is your *Hexagon* compleat, as required. Fig. 74.

PROP. III.

To fortifie a Hexagon according to Manesson Mallet's *Proportion.*

Now our Authour *Monsieur Manesson Mallet*, in his Works intituled *Travaux de Mars*, deviates from our former Authour, only in this: that as *De la Mont* did place his *Flanks* at *Right Angles*, he places them at 98 *Degrees* with the *Curtains*, and leaves no *second Flank* in all his *Fortifications*.

Therefore having described the *Polygon* PP, *&c.* divide PP into 1000 parts, prick off the *Capitals* PA 333, and the *Gorges* PC 200, then lay off the *Flanks* CF, 150 parts, at an Angle of Fig. 74.

§. 3. of 98 deg. with the Curtain CC (by prop. 5. §. 1. chap. 4.) and draw all the *Faces*, AF, AF, *&c.* Falling on C the point of the *Flank* and *Curtain*, so shall your *Hexagon* be fortified as was required.

III. *Of the* Dutch *Fortifications.*

Fig. 74. The *Emperour Ferdinand* III. hath learnedly altered the Method of *Fritach*, *Dogen*, *Goldman*, and *Faulhaberus*, all which were *Dutch Inginiers*, and wrote large Volumes on this Subject; in his Works intituled *Amussis Ferdinandea*, published 1654; by turning their way of working by Angles, into working by Sides.

Thus he setteth down a Catholick way of delineating the Sides, or Lines of any Fort by his 60 prop. thus, the *Interior Polygon* to be 66, the *Capital* 24, the *Gorge* 15, and the *Flank* 12. Or in making the *Interior Polygon* 22, the *Capital* 8, the *Gorge* 5, and the *Flank* 4. Or yet making the *Interior Polygon* 1000, the *Capital* 363, the *Gorge* 227, and the *Flank* 181, this is an *Epitome* of all the *Dutch Fortifications*, and is general excepting for the *Square*, which

Fig. 74. must have no *second Flank*.

PROP. IV.

To fortifie a Hexagon according to the Emperour's Proportion.

First describe the *Polygon* PPP, *&c.* divide P P, *&c.* into 22 parts, take 8 for the *Capitals*

PA, which

PA, which prick off all round from P to A, §. 3.
take 5 for the *Gorges*; which prick off all round from C to P, then take 4 for the *Flank* CF, *Fig.* 74.
which prick off all round at Right-angles from C to F, lastly draw the *Faces* AF, AF, AF, *&c.* So is the *Hexagon* compleated as was required.

IV. *Of the* English *Fortifications.*

His late Majesty of Great Britain Carolus II. of ever blessed Memory, hath much facilitated the Method of Count *Pagan*, who in his Fortifications printed at *Paris* 1645, did place the *Flanks* at Right-angles with the *Line of Defence*, and he works by the *Exterior Polygon*. Now His *Majesty* places the *Flank*, at *Right-angles* with the line of defence of the *Interior Polygon*, and works after another manner: *Count Pagan* makes the proportion of the *Grand Royal Fort*. Supposing the *Exterior Polygon* to be 1000 parts, will make the *Perpendicular* MT to be 150, and *Fig.* 74.
the *Complement* of the line of *Defence* TC to be 185, which may serve for a general proportion be the length what it will, only in a *Square* the proportions must thus be altered in the *Grand Royal Fort*, the *Perpendicular* MT must be 162, in the *Mean* R 144, and in the *Petty Royal* 126, the *Complement of the Line of Defence* for the *Grand Royal Fort is* 228, and for the *Mean Royal Fort* 198, also for the *Petty Royal Fort* 198:

PROP.

§. 3.

PROP. V.

How to fortifie a Hexagon according to Count Pagan's *Proportion.*

To delineate this Work draw a line, about the middle whereof as at M, set off MA, the half of the *Exterior Polygon* 500 parts, which makes the *Exterior Polygon* 1000, then on M
Fig. 74. (by prop. 1. §. 1. chap. 4.) raise the *Perpendicular* Mm, which make Mt, MT *Equal* to 150, then draw ATC, and ATC, then take 185, and place it from T to C, and to C, and draw CC for the *Curtain*, then on the points C raise *Perpendiculars* CF, to the line of defence CA, for the *Flanks*, so have you also the *Faces* FA. Then on the Points A set off half the Angle of the Figure, to wit 60° (as you see in the Table in page 38) and draw the lines OA and O A, so shall O be the Center of the Figure, and
Fig. 74. PC the *Gorge*, and AP the *Capitals*: then finish each Bastion at your own discretion, and the Work is finished as required.

PROP. VI.

To fortifie a Hexagon according to the way prescribed by His Majesty Carolus II.

His late Majesty *C. II.* hath much facilitated this Work, as will appear in this following Example, by making the line of *Defence*, stand at *Right-angles* with the *Flank* of the *Interior Polygon*, by this Table, which supposes the *Interior Polygon* to be 1000. Then
Fig. 74.

Polygons

§. 3.

Polygons	4	5	6	7	8	9	10	*Strait-lines.*
Capital	398	437	367	333	312	300	291	233
Gorge-line	155	196	203	242	252	260	263	300

Now deſcribe the *Hexagon* PP, *&c.* Then divide the *Interior Poligon* PP, into 1000 parts, take 367 and prick off all the *Capitals* PA; Then take 203 and prick off all the *Gorges* from P to C. Now draw the *lines of defence* AC and AC, *&c.* Then at C, ſet the *Flanks* at Right Angles with the line of Defence AC, ſo ſhall FC be the *Flank*, and FA the *Faces*, then finiſh every *Baſtion*, and your *Hexagon* is fortified as was required. *Fig.* 74.

☞ Thus have I ſet down the ſeveral Ways and Rules, for laying the fundamental Ground-line, from the moſt conſiderable Inginiers of this laſt Age, out of all which it's moſt agreeable to thoſe Authors, and to practice, to take $\frac{1}{3}$ of the *Interior Polygon* for the *Capital*, $\frac{1}{5}$ for the *Gorge*, and *Flank*, which leaves $\frac{6}{10}$ for the *Curtain*, and let this be taken for a general Rule, where the *Flank*, and *Curtain*, ſtand at *Right Angles*.

Obſerve this for a general Rule in Regular Fortification.

PROP.

§. 3.

PROP. VII.

By the Semicircle to lay down on the Ground, any of the former Fortifications.

Fig. 76. Having drawn the Plot of your *Fort* on Imperial paper, or *Vellom*, and if it be a Regular Fort you need not deſcribe it but two half *Baſtions* from the Center, for that will be ſufficient. Having ſuch a Plate whoſe length is ſet down on each reſpective line, and all proper Angles expreſſed, will not only be uſefull for laying down the Work, but for finding the Solidity of the *Ramparts*, *Parapets*, and the other Earth Works. See Fig. 76.

Caſe 1. If it be in ſuch a Place, that from the Center of the Fort, all the Angles may be ſeen, place your *Semicircle* at Z, and lay off all the Angles of the Center, which here is 60°; then mark out the *Diametrical lines*, and making them their due length, as by your Plate they appear to be, ſet *Piquets*, on all the P, P's upright with the *Plane*, Then take up your Inſtrument and place a *Piquet* at Z. Then lock-ſpit out all the *Polygons*. PP. Then mark out the *Gorges* CP, *Fig.* 76. then ſet out the *Flanks* CF, either at Right Angles, or as otherwiſe required. Then lock-ſpit out the *Flanks* CF, and the *Faces* AF, having firſt ſet off the *Capital* PA, ſo is the Fort lined out for the *Ground-line*.

Caſe 2. But if there be *Houſes* and *Obſtacles* in the way, that from the Center all may not be ſeen, then muſt you mark out any one ſide and meaſure it, and at each End ſet off the *Angles* of the

the *Polygon*, (which here is 120°) and draw side after side, untill all be finished: Then finish the *Bastions* as before, and here great care must be had, or else you will run into infinite Errours. §. 3.

☞ But you have liberty Experimentally to alter any of the former proportions, as you have occasion, and as will best serve the Place; as you see by the fortifying a streight lined Figure: Fig. 77. wherein *Count Pagan's* or in *Manesson's* way it may not be allowed without some alterations. *Fig.* 77.

SECT. IV.

Of the Dimensions, and Measures of the Rampires, Parapets, Mote, Coridor, or Covert-way, and its Esplanade, or Breast-work. §. 4.

THE *Rampire's* thickness and height, must receive its Determination from the *Judgment* of the *Inginiers*, and Purse of the *Prince*.

The *Height* TS, must not exceed 18 Feet, nor be less than Ten; the thickness may be from 50, to 80 RA, in all *Royal Works*, and according as Earth is to be had. The slope of the inward side of the *Rampire* TR, is commonly a foot for a foot, therefore RS, the *Talu*, will be equal to the Height TS, so if TS be 18, RS will be 18, if 15 then 15 feet. *Fig.* 78.

The

§. 3. The outward Slope QA, is generally proportioned ½ a Foot for a Foot, so if the Height OQ be 18, the *Talu* OA, will be 9 Feet, *&c.*

Fig. 78. The Height of the *Parapet* ZD, must always be 6 Feet, the *Exterior Height* PM must be 4 Feet, the thickness of the Parapet DQ, in light Earth must be 20 Feet, in stiff Earth 16, and in Solid Rough Clay 14 Feet; suppose it be 18 Feet, PM will be 4 Feet, MQ 2 Feet, LD 1 Foot, so will the lower thickness LQ be 21 Feet.

The Height of the *Banquet* VX is 1½ Foot, and thickness VL, 3 Feet.

The *Lizier* must be made so wide, as to support the *Rampire* from slipping into the *Ditch*, and is taken from 3, to 10 Feet; the *Mote* or *Ditch* may be from 70, to 130 Feet broad, that is, from E to G, and the depth IF may be 8, 10, or 12 Foot deep, the little Ditch at the bottom of the *Mote* represented by c q g, must be as large and deep as the Earth and Work will give leave.

Fig. 78. The *Coridor* and the *Esplanade* or Breast-work on it, is left about 18 Feet wide, from G to C; on which is placed a *Parapet*, and *Banquet*, like that on the *Rampire*, which *Parapet* or *Esplanade*, must slope so into the *Campaigne*, that a streight line drawn from Z, the Top of the *Rampire*, may terminate OFd, the Slope thereof.

PROP.

PROP. VIII. §. 4.

How to lay down the Profile of the Work, according to this Table.

	Feet.
The Base of the Rampart RA	70
Height TS *and* QO	16
Interior Talu RS	16
Exterior Talu OA	8
Base of the Parapet LQ	21
Interior Height ZD	6
Exterior Height MP	4
Exterior Talu MQ	2
Interior Talu QD	1
Breadth of the Banquet V, L	3
Height of it V, X	$1\frac{1}{2}$
The Terra Plana TV	25
The Lizier AE	3
The Mote's breadth EG	112 *Fig.* 78.
The Depth of it IF	12
Breadth at its bottom FH	88
The Talus EI, *or* KG	12
The Breadth of the little Ditch c g.	18
The Depth of it	5
The Coridor GC	18
The Seat of the Esplanade	60
The Height CF	6

Now to lay down this *Profile* draw a line of a convenient length as RSOACGD for the level or Ground-line, then by your Scale of 20, or 30, at most in an Inch, representing Feet. Take out of it 70 for RA, 16 for RS, 8

§. 4. for OA, 3 for AE, 112 for EG, 18 for GC, and 60 for CD, and mark them off on your Fig. 78. Paper (as in Fig. 78.) at S, O, I, K, C, raise or let fall *Perpendiculars* (by prop. 1, 2, or 3. §. 1. chap. 4.) then take 16 for ST, and OQ, 12 for IF and KH, and 6 for Cf, and draw RT, TQ, QA, EF, HG, cf, fd: Then from Q set off QL 12, LV 3, QM 2, and LD 1, and raise the *Perpendiculars* MP 4, DZ 6, and VX $1\frac{1}{2}$. Then draw VX, XY, YZ, ZP, and PQ, and make the little Ditch by its measure, so is the *Profile* perfected: as for the *Faus-Bray*, they are now out of use, therefore I omit them.

The Solid Content of those Earth-Works, may easily be attained by the former Rules, which Content being got in Feet, divide that product by 324, the Quotient shall be the *Solid Flores* contained therein, a Flore being 18 Foot square and 1 Foot deep.

SECT. V.

§. 5. *Of the Dimensions and Construction of Platforms, Caveleers and Cazemats in the Flanks.*

1. PLatforms are Plantations where *Guns* are to be placed, and are commonly made of *Plank*, and *Sleepers*, there needeth for one *Gun*, to be but one *Platform*, which must

must be 8 Feet broad next the *Parapet*, and 14 Feet wide at the other End, and their length should be 18 Feet. §. 5.

2. An *Embrasure* is the *Port-Hole* made in the *Parapet*, which towards the Gun must be 4 Feet wide, and towards the *Campaigne* 8 Feet wide, whose height must be proportioned unto the Wheel of the Carriage; and are 16, 18 or 20 Feet assunder.

3. *Cavaleers* or *Mounts* are Massy pieces of Earth raised on or near the *Rampart*, above the *Parapet*, on which *Ordnance* and small shot may be planted. As to their Construction I shall follow the Method of *Manesson*, who places them in the *Gorge* of the *Bastion*, and gives this Rule for it, [saith he] "Lengthen out *Fig.* 79.
"*the line of defence* to E, untill it cut the *Capi-*
"*tal*, the Center of your *Cavaleer* shall be the
"middle point betwixt P and E, to wit at F,
"then with the distance of 84 Feet on the
"Center F strike a Circle, which shall be the
"*Base* of your *Cavaleer*: Now its height ought to be at least 20 Feet; and if the Work be to be faced with Stone, or Brick it needs not not have a *Talu* above $3\frac{1}{2}$ Feet, so that the *Diameter* at the top will be about 153 Feet, whereon set a *Parapet* of 20 Seat, and high, and other Demensions as aforesaid in the *Rampire*, and there will be a *Terra-plana* at the top of above 100 Feet, whereon six pieces of *Ordnance* may be planted, making *Embrasures* and *Platforms* as was last directed.

4. *Cazemats* are made in the Corners of the *Flanks*, and are several *Platforms* for *Guns* to be planted on, thereby to be hid from the

§ 5. Battery of the Enemy: As to the Construction I shall follow *Manesson's* Directions, first as to the form, and also to the measure: [saith he] " The *Caremate* shall take up one half of the " *Flank*, and no more; The *Grand Caremate* D " B is about 7, 8 or 9 Feet from the Level of " the Plane of the Fort, and hath a passage into " it from within the Fort A, C is its *Parapet* of 20 " or 22 Foot Seat, and in it let there be 3 or 4 " *Embrasures*; D is the part thereof most hid " from the Enemies *Cannon*; F is the *Magazine*
Fig. 79. " for this *Battery*; H is the second *Caremate*, G " the *Ladder*, and L the *Magazine*, and M the " *Parapet*; this is to hold but one Gun; M is the " third *Caremate* on the level of the *Bast*. which " let be all firm, in which let there be no void " place. The *Dimensions* and *Construction* according to the Method of this our Authour are thus [saith he] " Lengthen the *Line of Defence* " from C to G some 40 Feet, then draw CD, " *parallel* to C f, (by prop. 4. §. 1. chap. 4.) let " CF be half of c f, so that c F may be equal to " F f, then from the middle of the *Face* opposed, " draw KF, and let it cut GD, in I, then make I
Fig. 79. " L, and FM equal to 6 Feet, then make MN 66 " Feet, and draw NO *parallel* to the *Flank*, " which let be 24 Feet: Lastly [saith he] for " the *Orillon* or Blind, prolong the Face FT 36 " Feet, and also FV 36 Feet, then joyn TV, and " make that part all solid: So is your *Caremate* " finished: Let the height of the lower *Cazemat*, be 6 Feet as before, and let all the rest " be compleated as you see in the Figure.

SECT.

SECT. VI.

Of the Dimensions, and Constructions of those Out-Works, called Ravelins, Horn, Crown-works, &c. §. 6.

THE *Ravelin* is a certain Work lying beyond the *Mote*, or *Ditch*, for the covering the *Curtain*, *Bridge*, and *Gate*; the Angle of the *Ravelin* must not be less than 60, nor much above 100 deg. the manner of delineating it is thus. Lengthen out the middle line of the *Curtain* OM unto a convenient length, *Fig.* 80. then take with your *Compasses* the length of the *Curtain* CC, and setting on Foot in F, the point of the *Face* and *Flank*, cross the middle line in q; then laying your Ruler at q, and to the points F, draw the lines of the *Ravelin* q R and q S, which shall be the Ground-lines of the *Ravelin*: The *Mote* surrounding it must be half the breadth of the *Great Mote*; the *Rampert* may be 30 Feet thick, and some 6, 7 or 8 Feet high, on which may stand a *Parapet* equal to that of the *Rampire*.

Now if from the points F you raise streight lines into the *Campaign*, at *Right Angles* to the *Curtain*, and from the points F set off FE, and FE 720 or 750 Feet, then may you joyn EE *Fig.* 81. either with, A;

Single Tenaille: which is done by joyning EE, and dividing it into four equal parts, take one and place from D to N, and so draw EN

V 3 and

§. 6. and EN, ſo have you a *Single Tenail* IENEL, which muſt have a *Mote Rampire*, and *Parapet* like the *Ravelin*. *Secondly* it may if occaſion require be fortified with, A;

Horn-Work: which is done by joyning the points E E, and fortifying the *Exterior Polygon* EE as is afore taught: Or divide EE into three parts; make ME, and EN equal to MO; then draw N M, which divide ſo likewiſe at O and P; then draw E O and E P; then at P and O raiſe *Perpendiculars* O Q and PR, ſo ſhall M, E, Q, O, P, R, E, N, be the *Horn-Work* which was deſired: which muſt likewiſe have ſmall *Rampires* and *Parapets*, as afore.

Fig. 83.

For the *Crown-Work*: From the Center of the Fort O draw O M B of a convenient length, then from the middle of the *Ravelin* ſet off 1000 or 800 Feet to B, then on q, ſtrike the *Arch* D B E, ſet off the *Curtain*, and *Demi-Gorge* P C C, from B to F, and G both ways, then draw C F and C E, to terminate the points I and H on the *Counterſcarp*; then take $\frac{1}{3}$ part of B F or B E, and ſet it from B to M, and from F to L, and from E to M; then draw L M, and M N; then for your *Demi-Baſtions* make N P and L O equal to N E, &c. Then for the *Demi-Gorges* of the whole *Baſtion* in the middle, let them be equal to $\frac{1}{5}$ of the *Interiour Poligon* L M or M N, *viz.* M Y or M X; then finiſh the *Baſtions* by drawing the lines of *Defence*, and raiſing *Perpendiculars*, or making *Angles* of 98° at O, X, Y, and P, then the *Crown-work* is finiſhed as deſired. You may make *Ravelins* and other Works (beforementioned) before theſe *Curtains* if occaſion require.

Fig. 84.

There

There are ſome other Works which are uſed; as *Half Moons*, *Bonnets*, *Double Tenails*, *Counter-gards*, *Horſeſhoes*, *Prieſts-Caps*, &c. which would be ſuperfluous to ſpeak of in this place. §. 6.

5. *Cittadels*, are *Caſtles* or *Forts* of the leaſt ſort, and are the Out-works laſtly uſed, which are * commonly of 4 or 5 *Baſtions*, and are placed in ſuch Order, that there may be two *Faces*, and a *Curtain* towards the Town: the Conſtruction whereof is after this manner. Lengthen out the line OM, and therein find the Center of the *Cittadel*, the *Interior Polygon* of the *Pentagon* may be $\frac{3}{4}$ of the *Curtain* adjoyning, or a little more; the Center of the *Square* may be on P the point of the *Interior Polygon*, the Center of the *Hexagon* may be near the outward point of the *Baſtion* of the *Town*, taken away to make the *Cittadel* in, which may be delineated as afore: The *Motes* and other Works in proportion accordingly, and the *Rampires* as high as thoſe of the City or Town.

* *Built to bridle the Town or the Place, leſt the Burghers ſhould be rebellious, and to be the laſt refuge or place of retreat.*

SECT. VII.

§. 7. Of some Maxims or Rules necessary to be known in Irregular Fortification.

IRregular Fortifications is when any Town or Place is to be fortified, which lieth in an Irregular form; *i. e.* whose Sides and Angles are unequal in the fortifying of *Irregular Figures* *. I shall here say very little, only I shall lay down some Precepts that are of immediate concern in fortifying of Irregular Figures, and shall refer you to peruse *Marlois*, *Dogen*, *Fritach*, *Taurnier*, *Dilichius*, &c. which will greatly satisfie and help you: To this end know,

* *The Inginier must first form a Map of the Town or Place, with all the Ways, Passages, Old Walls, Rivers, Pools, Enclosures, and all other matters fit to be known in the draught, and then he is to design what Works he findeth most agreeing to the place to be Fortified.*

1. That the same *Laws* and *Maxims* for *Regular Fortifications* stand and be in force for *Irregular*; *i. e.* that the line of *Defence* must not exceed the *Port* of a *Musquet*, nor the *Angles* of the *Bastion* be less than 60°, nor much above 90°, *&c.*

2. That no inward Angle of the Place be less than 90°, if it be so it must be altered, and that point may be made the outward point of a *Bastion.*

3. That

3. That between *Regular* and *Irregular Fortifications*, there is no other difference, but by rectifying the sides that are too short, or too long, and altering the Angles that are too little; as for the sides, if they be above 500, and under 1000 Feet, they may be fortified by *Bastions* placed according to the usual manner, at the extreme points thereof; But if the sides be between 1000 and 1700 Feet, then in the midst you may place a *Plat Bastion*, and at the *Extreme Points*, place two *Bastions*, as before: But if the line be less than 500 Feet, you may lengthen it, by producing it into the *Plane*: As for the *Angles*, they are made greater or lesser according as occasion requireth. For the Raising the *Rampires*, *Parapets*, and other Outworks, they are to be as in the *Regular*, and the Out-work may be placed before the *Curtains* as was before mentioned. §. 7.

4. That the *Capital*, in any *Regular* or *Irregular Bastion*, is found by dividing the *Angle* of the *Polygon* into two equal parts (by prop. 7. §. 1. chap. 4.) and by producing the line of *Angular Division* or *Separation*, on which the due length of the *Capital* must be placed, which observe for a general Rule.

SECT.

SECT. VIII.

§. 8. *Of the Dimensions and Construction of small Forts, or Sconces, which are built for the Defence of some Pass, River, or other place.*

WHEN they are made Regular, of 4, 5, or 6 *Bastions*, then they may be fortified by the precedent Rules, but there are others of smaller Dimensions fit for the same purpose: *viz. Triangle* with *Demi-Bastions*, *Square* with *Demi-Bastions*, *Parallelograms* with *Demi-Bastions* and *Tong*, *Star Redoubts* of four, five or six points, and *Plain Redoubts*.

PROP. IX.

To fortifie a Triangle, with Demi-Bastions.

This *Triangle* may consist and be comprehended of three equal or unequal sides in this Fig. 84. Example: let it be an *Equilaterial Triangle* PPP. Now divide PP into three parts, then take 1, and prick off the *Capitals* PA, &c. and the *Gorges* make equal thereunto, as PC, PC, &c. then make the *Flanks* FC to stand at *Right Angles*, and to be ½ of PC or PA, then draw the *Faces* AF, AF, &c. and the Work is finished as required.

PROP.

§. 8.

PROP. X.

To fortifie a Square with Demi-Bastions.

The sides of the *Square* may be from 100 to 200 Feet, let PP be 180 Feet, which divide into 3 parts, take one for the *Gorges* PC, and for the *Capitals* PA, and prick them off all round as you see, then take $\frac{1}{6}$ of PP, and at *Right Angles* prick off the *Flanks* CF, then draw the *Faces* AF, AF, *&c.* and the Figure is compleated. *Fig.* 85.

PROP. XI.

To fortifie a Parallelogram *with Demi-Bastions, and Tong.*

First describe the *Parallelogram*, or *Long-Square*, PPPP, then divide PP into 6 parts (the side on which the *Tong*, or *Tenaile*, is placed) and make MC equal unto $\frac{1}{6}$ thereof, and also MG, and MH. Draw CG, GC, and CH, HC, then finish the *Demi-Bastions* as before, so shall the Work be compleated as was required. A *Long Square* may also be fortified as Fig. the 77. *Fig.* 86.

PROP. XII.

To fortifie a Star Redoubt of 4, 5, or 6 Points.

1. *A Star Redoubt of four points* may have his side from 40 to 60 Feet: First describe the *Square* PPPP, then divide PP into two parts at M, take $\frac{1}{4}$ of PM, (and by prop. 1. §. 1. ch. 4.) *Fig.* 87.

raise

§. 8. raise *Perpendiculars* round at M, make MA equal to $\frac{1}{4}$ of PM, and draw all as in the Figure.

2. *A Star Redoubt of five points* is thus fortified. Describe the *Pentagon* PP, *&c.* then divide PP into halves at M, raise the *Perpendiculars* MA, make MA equal to $\frac{1}{3}$ of PM, and draw the *Fort*

Fig. 88. in all respects as the Figure representeth.

3. *A Star Redoubt of six points* is thus fortified. Describe the *Hexagon* PPP, *&c.* divide PP into two equal parts at M, then raise *Perpendiculars* at the M's, then make MA equal to $\frac{1}{2}$ of PM,

Fig. 89. or $\frac{1}{4}$ of PP, and draw every respective line as you see in the Figure.

PROP. XIII.

To Delineate a Plain Redoubt.

Plain Redoubts are called *Grand Redoubts*, which are used as *Batteries* in *Approaches*, whose

Fig. 90. side may be from 60 to 80 Feet; or *Petit Redoubt*, which are used for a *Court of Guards* in the *Trenches*, and may be from 20 to 50 Feet, and are framed and delineated in all respects as you see in Fig. 90.

The *Profile's* to be set on these several Works, and the *Motes*, are alterable and uncertain, for they being sometimes used in *Approaches*; then they do require the *Breast-work* at the *Bottom* to be 7 or 8 Foot wide, and the *Interior Height* 6, and the *Exterior* 5 Feet, and the *Mote* to be either 8, 10 or 12 Feet, sometimes 14 or 20 Feet wide at the bottom, and the height of 7, 8 or 9 Feet, to have two, or three ascents

ascents to rise to the *Parapet*. There are many other things belonging to this Art, which the limitation I am bound to, will not permit here to be treated of. §. 8.

CHAP. XIV.

Of Military Orders, or the *Embattelling and Encamping of Souldiers.*

SECT. I.

Of the Embattelling and Ordering of Souldiers. §. 1.

BATTAILS *are considered either in respect of the number of Men, or in respect of the form of Ground. In the respect of the number of Men, it is either a Square Battail, a Double Battail, a Battail of the Grand Front, or a Battail of any proportion, of the number in Rank to the number in File. In respect of the form of the Ground, the Battail is either a Geometrical Square of Ground, or a long Square of Ground. For the Distance, or Order of Souldiers, martialled*

§. 1. *martialled in Array, is distinguished either into* Open Order, *which is when the Centers of their places are 7 Feet distant assuunder, both in Rank and File, or* Order; *which is when the Centers of the places are* $3\frac{1}{2}$ *Feet distant both in Rank and File; or else* $3\frac{1}{2}$ *Feet in Rank, and 7 Feet in File.*

PROP. I.

To Order any number of Souldiers into a Square Battail of Men.

Admit it were required to Martial into a *Square Battail* 16129 Men: To doe which extract the Square Root of 16129 (by prop. 8. §. 1. chap. 1.) which is 127, therefore you are to place 127 Men in *Rank*, and also in *File*.

PROP. II.

To Order any number of Souldiers into a Double Battail.

Admit 16928 Men were to be Martialled into a *Double Battail*, extract the Root of half the number of Men; *i. e.* of 8464, whose Root is 92, therefore I say that 92 Men must be placed in *File*, and 184 in *Rank*, to order that number of Men propounded into a *Double Battail.*

PROP.

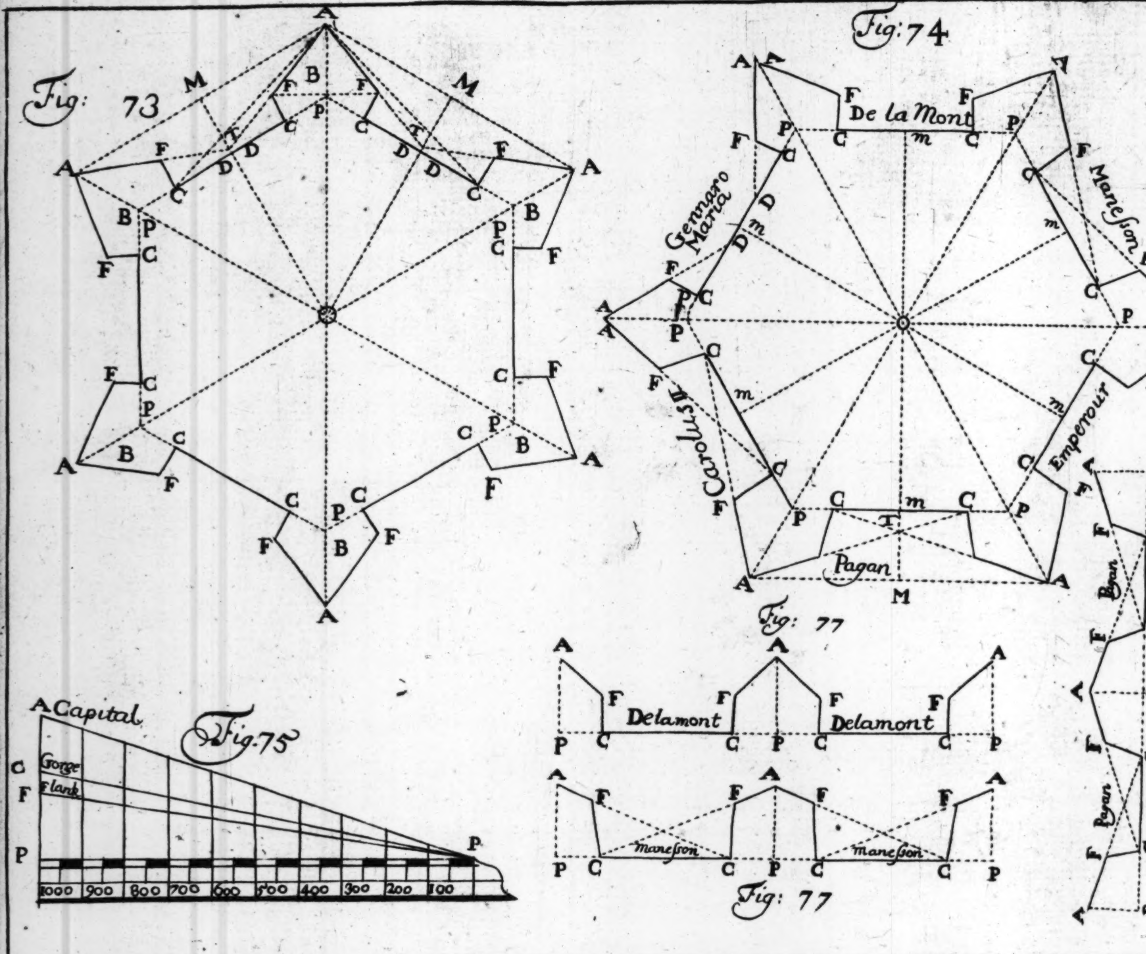
Fig: 73
Fig: 74
De la Mont
Gennaro Maria
Manesson
Carolus II
Emperour
Pagan
Fig: 77
Delamont
Delamont
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maneſson
Fig: 77
Capital
Gorge
Flank
Fig. 75
1000 900 800 700 600 500 400 300 200 100

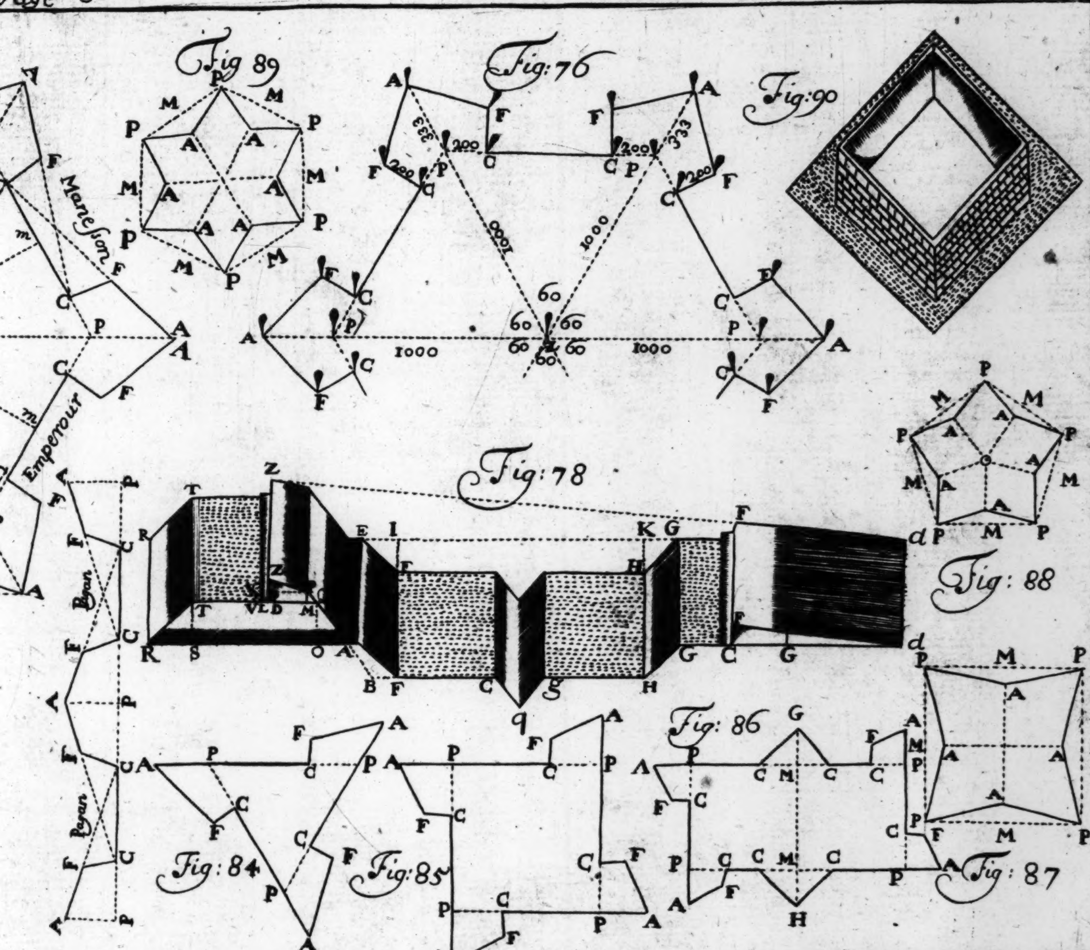


Fig 89
Fig:76
Fig:90
Manesson
Emperour
Fig:78
Fig: 88
Fig: 86
Fig: 84
Fig: 85
Fig: 87

§. 1.

PROP. III.

To Order any number of Souldiers into a Battail of the Grand Front.

Admit 16900 *Souldiers* were to be Martialled into a *Battail* of the *Grand Front*, that is *Quadruple*. Extract the Square Root of 4225 (that is $\frac{1}{4}$ of the Men) the Root is 65; therefore I say 65 must be placed in *File*, and 260 in *Rank*, to form a *Battail* of the *Grand Front*.

PROP. IV.

Any number of Men, together with their distance in Rank and File, being propounded, to Order them into a Square Battail of Ground.

Admit 2500 *Souldiers* were to be Martialled into a *Square Battail of Ground*, in such sort that their distance in *File* should be 7 feet, and in *Rank* 3 feet, and 'tis required to know how many Men must be placed in *Rank* and in *File* to draw up 2500 Men into *Square Battail* of the *Ground*. According to prop. 1. §. 1. ch. 1. say, *As* ——— 7 to 3, *So is* 2500 to 1071, &c. whose Square Root is 32, &c. Therefore I say 32 Men are to be placed in *File*. Now to find how many Men are to be placed in *Rank*, divide 2500 by 32, the Quotient is 78, which are the number of Men to be placed in *Rank*, and 4 Men to be disposed elsewhere.

PROP.

§. 1.

PROP. V.

Any number of Souldiers propounded, to Order them in Rank and File, according to the reason of any two Numbers given.

Admit 6400 *Souldiers* are to be Martialled into *Array*, in such *Order* that the number of Men placed in *File*, shall bear such proportion to the number in *Rank* as 7 to 13; (according to prop. 1. §. 1. chap. 1.) say as 7 to 13, so is 6400 to 11885, &c. whose Square Root is 109, &c. the number of Men to be placed in *Rank*, by which divide 6400, it produces, 58, &c. the number of Men to be placed in *File*, and 78 Men to be employed elsewhere.

SECT. II.

§. 2. *Of Castermetation, or Quartering and Encamping of Souldiers.*

IN Quartering and Encamping of *Souldiers*, it is requisite, the *Quarter-Master General*, and all other under *Quarter-Masters*, be skilled at Foot measure, that so they may lay out their Quarters as directed.

The common allowance for the depth of Ground, that a *Regiment of Horse* or *Foot* will take up, the wideness must be answerable to the

the Number of Men 200 Feet for the *Huts* in length, and 100 for the *Commanders*, and *Sutlers*, before them; every two *Souldiers* to a *Hut*; 8 Feet broad, and 8 Feet deep, 2 Feet *Hut*; from *Hut*, so that there may stand 20 *Huts* in the 200 Feet, the Ally betwixt *Hut*, and *Hut*, may be 8 Feet, that is 16 Feet in width, and 200 in length for 40 Men, which is 3200 Feet, and for the 100 Feet more, 1600 Feet, in all 4800 Feet, and there must be 25 Rows of *Huts*, for 1000 Men; so that for a *Regiment of Foot* containing 1000 Men, with *Officers*, and *Sutlers*, will take up 120000 Feet, which is 2 *Acres* and 3 *Roods*, which because of Ways may be allowed 3 *Acres* of Ground, for every *Regiment*, which may be 350 Feet deep, and 370 Feet wide, or near 360 Feet square: Now if 1000 Men, *Officers*, *Sutlers*, *High-ways* and all take up a Square of 360 Feet, how many Feet shall the Side of a Square be wherein 10000 *Footmen*, &c. may be encamped? say (by prop. 1. chap. 1.) as 1000, to 10000, so is the Square of 360, *viz.* 129600, to 1296000, the Square of 1138 Feet, which is very near 30 Acres of Ground. §. 2.

For the Quartering of *Horse*, you must keep the same depth of 300 Feet for all, and take 200 Feet for the *Huts*, the *Horse Huts* must be 10 Feet deep, and 4 wide; so that 12 *Horses* may stand in one *Hut* together, which is 48 Feet long, and 10 wide, and 6 Feet a Street; The *Huts* for the *Troops*, will be 6, for 12 *Troops*; now conceive a *Regiment* to consist of 8 *Troops*, 50 to a *Troop*, it will take up leaving 20 Feet Streets, and Cross-ways, very near as much Ground as a *Regiment of Foot*, Ways and all must be allowed

§ 2. 3 *Acres*, near 360 *Feet square*, so that 10 Regiments of Horse will take up 30 *Acres*: Moreover, it will be needfull and you may very well allow, as much ground as both *Horse* and *Foot* will take, for the *Train of Artillery, Victuallers, Parade* Places, *&c.* From these considerations the young beginner, nay even the better practised Souldier may receive help, and thereby be enabled to Encamp an Army if required.

CHAP. XV.

Of GUNNERY.

SECT. I.

§. 1. *Of the Names of the Principal Members of a Piece of Ordnance.*

1. *Defin.* A CANNON is a long round Body, either of *Brass*, or *Iron*, formed and made hollow by Art, and proportion, to offend afar off, with a *Ball* of *Iron, Stone*, or any Artificial Substance, charged with *Gun-Powder*, in its charged *Cilinder*, which being fired, in an instant performs its

its desired Effect. This *Machine* was invented by an *Englishman*, and first put in practice by the *Venetians* against the *Genoveses* at *Chiezza*, Anno 1376. §. 1.

This Military Engine Bombarda, *Gun, Cannon,* &c. *So called from* Bombo, *a resounding Noise,* Cannone, *or Cannon, from the likeness it holds with his* Canna, *Bore, or Concavity*; Artigleria, *from* Artiglio, *the Talons, or Claws of Ravenous Fowls, because its shot flying afar off tears and defaces all that it doth meet; from whence some Natures of this Machine are called* Smeriglii, *long winged Hawks,* Falconi, *Faloonets*; Passa volanti, *swift flying Arrows,* &c.

2. The *Superficies* of the *Mettal*, is the outside round about the *Piece*.

3. The Body is the Substance of the whole Mass of Mettal.

4. The *Chase* is the Concavity of the Piece, in which they put the Charge.

5. the *Muzzel* is the Extremity of the *Chase* by which you load, and unload the Piece.

6. The *Calibre* is AB the *Diameter* of the *Muzzel* or *Mouth*. Fig. 91.

7. The *Touch-hole*, is that little *vent*, which passeth from the *Convex Superficies*, to the very *Chamber* of the *Piece*, made to give fire to the *Powder* within as C, that which encloseth the Extremity of the *Chase* about the *Touch-hole* is called the *Breech* or *Coyl*.

8. The *Cascabel* is the *Pammel* at the *Breech* or Coyl as D.

The *Trunnions*, are pieces of Metal fixed unto the *Exterior Superficies* of the *Gun* on which he moves in the *Carriage* as E, E.

§. 1. The *Body* of the *Piece*, is that which is comprehended betwixt the Center of the *Trunnions*
Fig. 91. and the *Cascable* EG.

The *Vacant Cylinder*, is comprehended betwixt the Cent. of the *Trunnions* & the *Muzzel* as EB.

The *Frees*, or *Muzzel Ring* is that thick *Cornish* which incompasseth the *Convex Superficies* of the *Piece* at I, The *Base Ring* is KLG, *The Reinforced Ring* is M, *The Trunnion Ring is* N, and the *Cornish Ring is* O.

The *Line of the Cylinder*, is a direct line imagined to be described along the *Chase Parallel* unto the middle of the *Chase* as XZ.

Fig. 91. The *Line of Metal*, is a line touching both *Cornishes*, as MNI.

The *Dispart line* of the *Piece*, is the difference betwixt the *Semidiameter* of the *Muzzel*, and *Base Ring* as the line IH.

The *Vent* of the Piece is the difference betwixt the *Diameter* of the Shot, and the *Mouth* of the *Piece*, as e d.

The *Chamber*, or Charged *Cylinder*, is that part of the *Chase* towards the *Touch-hole* equally large, nor narrower in one place than in another, and doth contain the *Powder* and *Ball*.

---

§. 2.

SECT. II.

Of the Dimension of our Usual English Cannon, and other Ordnance, &c.

IN the following Table I have set down the length and weight of our most usual English *Ordnance*, the *Diameters* and Weight of their *Bullets*, the length and breadth of their *Ladles*, the Weight of *Powder* to Charge them, *&c.*

The Names of the ſeveral Pieces of Ordnance.	Guns length Feet	Guns length Inches	Guns weight Pounds	Guns bore Inches	Guns bore 8 parts	Bullets diamet. Inches	Bullets diamet. 8 parts	Bullets weight Pounds	Bullets weight Ounces	Ladles length Inches	Ladles length 8 parts	Ladles breadth Inches	Ladles breadth 8 parts	Powder weight Pounds	Powder weight Ounces	Shoots Level Paces	Utmoſt Random Paces
A Baſe.	4	6	200	1	2	1	1	0	5	4	0	2	0	0	8	60	600
A Rabinet.	5	6	300	1	4	1	3	0	8	4	1	2	4	0	2	70	700
A Falconet.	6	0	400	2	2	2	1	1	5	7	4	4	0	1	4	90	900
A Falcon.	7	0	750	2	6	2	5	2	8	8	2	4	4	2	4	130	1300
Minion ordinary.	7	0	800	3	0	2	7	3	4	8	4	5	0	2	8	120	1200
Minion largeſt.	8	0	1000	3	2	3	0	3	12	9	0	5	0	3	4	125	1250
Saker leaſt.	8	0	1400	3	4	3	2	4	12	9	6	6	4	3	6	150	1500
Saker ordinary.	9	0	1500	3	6	3	4	6	0	10	4	6	6	4	0	160	1600
Saker old ſort.	10	0	1800	4	0	3	6	7	5	11	0	7	2	5	0	163	1630
Demiculver leaſt.	10	0	2000	4	2	4	0	9	0	12	0	8	0	6	4	174	1740
Demiculver ordinary.	11	0	2700	4	4	4	2	10	11	12	6	8	0	7	4	175	1750
Demiculver old ſort.	11	0	3000	4	6	4	4	12	11	13	4	8	4	8	8	178	1780
Culverin leaſt.	11	0	4000	5	0	4	6	15	0	14	2	9	0	10	0	180	1800
Culverin ordinary.	12	0	4500	5	2	5	0	17	5	16	0	9	4	11	6	181	1810
Culverin largeſt.	12	0	4800	5	4	5	2	20	0	16	0	10	0	11	8	183	1830
Demicannon leaſt	11	0	5400	6	2	6	0	30	0	20	0	11	4	14	0	156	1560
Demicannon ordin.	12	0	5600	6	4	6	1	32	0	22	0	12	0	17	8	162	1620
Demicannon large	12	0	6000	6	6	6	3	36	0	22	6	12	6	18	0	180	1800
Cannon Royal	12	0	8000	8	0	7	4	58	0	24	0	14	0	32	8	185	1850

§. 2.

PROP. I.

How to know the different Fortification of a Piece of Ordnance.

In fortifying any Piece of *Ordnance* there are three degrees observed, as first *Legitimate Pieces*, which are those that are ordinarily fortified; secondly *Bastard Pieces*, which are such whose Fortification is lessened; thirdly *Double fortified Pieces*, or extraordinary *Pieces*.

The Fortification of any Piece of *Ordnance*, is accounted by the thickness of the *Metal* at the *Touch-hole*, *Trunnions*, and at the *Muzzel*, in proportion to the *Diameter* of the *Bore*.

The *Legitimate Pieces*, or the ordinary fortified Cannons, have $\frac{7}{8}$ at the *Touch-hole*, $\frac{5}{8}$ at the *Trunnions*, and $\frac{3}{8}$ at the *Muzzel* of the thickness of the bore, in thickness of Metal. *Bastard Cannons*, or lesned Cannons, have $\frac{3}{4}$ at their *Touch-hole*, or $\frac{12}{16}$, and $\frac{9}{16}$ at their *Trunnions*, and $\frac{5}{16}$ at their *Muzzel*: the *Double fortified Cannons* have full one *Diameter* of the *Bore* in thickness of Metal at the *Touch-hole*, and $\frac{11}{16}$ at the *Trunnions*, and $\frac{7}{16}$ at their *Muzzel*. Now all double fortified *Culverins*, &c. are $1\frac{1}{8}$ at the *Touch-hole*, $\frac{15}{16}$ at the *Trunnions*, and $\frac{9}{16}$ at the *Muzzel*, and the *Ordinary fortified Culverins*, are fortified every way as *double fortified Cannons*, and lesned *Culverins* as *Ordinary Cannons* in all respects.

PROP.

§. 2.

PROP. II.

How to know how much Powder is fit for proof, and what for service, for any Piece of Ordnance.

For *Cannons* take $\frac{4}{5}$ of the weight of their *Iron Bullet* of good Corn Powder for Proof, and for service $\frac{1}{2}$ the weight of the *Iron Bullet* is sufficient, especially for *Iron Ordnanoe*, which will not endure so much Powder, as *Brass* ones will receive by $\frac{1}{4}$ in Weight, for *Culverins* allow the whole Weight of the Shoot for Proof, and $\frac{2}{3}$ for Service. For *Sakers*, and *Falcons*, take $\frac{4}{5}$ of the Weight of the Shoot, and for lesser Pieces the whole weight may be used in service, untill they grow hot, but then there must be some abatement made at discretion, and take $1\frac{1}{3}$ of the weight of their *Iron Bullet* for Proof.

PROP. III.

To know what Bullet is fit to be used in any Piece of Ordnance.

The *Bullet* must be somewhat less than the Bore of the Gun, that so it may have vent in the discharge, some Authors affirm $\frac{1}{4}$ of an Inch less than the Bore will serve, all Ordnance, but this vent is too much for a *Falcon*, &c. and too little for a *Cannon*: therefore I approve them not, but commend Mr. *Phillipes*'s proportion * to your Use, which is to divide the Bore of the Gun into 20 equal parts; and let the *Diameter* of the Bullet be $\frac{19}{20}$ thereof, according to which proportion the precedent Table is calculated.

* *In his Mathematical Manual. page* 165.

§. 2.

PROP. IV.

By knowing the proportion of Metals one to another, and by knowing the Weight of one Ball, to know what any other ſhall weigh.

The common received proportions for *Metals* are theſe.

Lead is to *Iron* as 2, to 3.
Lead is to *Braſs* as 24, to 19.
Lead is to *Stone* as 4, to 1.
Iron is to *Lead* as 3, to 2.
Iron is to *Braſs* as 16, to 18.
Iron is to *Stone* as 3, to 8.

The more exact proportion betwixt Metals are thus known. Admit a *Cube*, or *Ball* of *Gold*, weigh 100 *l.* A Cube of any of thoſe Metals enſuing of the ſame bigneſs, ſhall bear ſuch proportion, as followeth, to the ſaid *Cube* of *Gold.*

	li.	pts.		li.	pts.
Gold.	100	00	*Iron.*	42	10
Quickſilver.	71	43	*Tinn.*	38	95
Lead.	60	53	*Stone.*	15	80
Silver.	54	39	*Water.*	05	68
Braſs.	47	37			

It is the opinion of Dr. *Wybard* in his *Tactometria*, that a Bullet of *Caſt Iron*, whoſe *Diameter* is 4 Inches, doth weigh 9 *l. Averdupoize weight.*

Now to find what any other Bullet, or *Cube* ſhall weigh; ſay (as in prop. 4. chap. 1.) As the *Cube* of the *Bullet* propounded, is to his weight, ſo is the *Cube* of another *Bullet* given, to his weight, and ſo obſerve ſtill this proportion.

SECT.

SECT. III.

Of the Qualification of an able Gunner, and necessary Operations before shooting, and in shooting. §. 3.

A *Gunner* ought to be a Man of Courage, Experience, and Vigilant; he ought to have good skill in *Arithmetick*, to know the Extraction of the *Roots*, &c. He ought to have skill in *Geometry*, to take *heights*, *distances*, &c. to know the Divisions and Use of his *Circle*, *Quadrant*, and *Quadret*; to know how to level, and to lay *Platforms*, and to raise *Batteries*. He must know the Names of all sorts of *Ordnance*, their *Weight*, the *Height* of their *Bore*, the *Height* and *Weight* of their *Shot*, the *length* and *breadth* of their *Ladles*, how much *Powder* to use for *proof*, and *action*; The *Shoots Level*, and the *Shoots Random*; He must know the Names of all the Members of a *Piece of Ordnance*, he must also know the *length*, *thickness* and *breadth* of all manner of *Carriages*, and must know all the parts thereof: *Viz.* the *Cheeks or Sides*, *the Axtree*, *Spokes*, *Nave*, *Hoops*, *Transomes*, *Bolts*, *Plates*, *Drawing-Hooks*, *the Clout*, *the Hole for the Linspin*, *the Shafts*, *the Thill and Thill-bolt*, *the Fore-lock*, *and Fore-lock-keys*, *Capsquares*, *the Fore-lock-pins* and *Chain*, *the Pintle* and *Bolt-hole*, *Fellows*, *Nayles*, *Fellow-bars*, *Stirropes*, the *Ruts* of the *Wheel*, *Dowledges*, *Beds*, *Coines*, *Leveres*, *Hand-screws*, &c. He must also know how to make his *Ladles*, *Spunges*, *Cartridges*,

§. 3. *ges*, whether of *Paper* or *Canvas*, and to have by him *Formeres* of all sorts, *Sheep-skins* undrest to make *Spunges*, *Powder*, *Shot*, *Needles*, *Thread*, *Paste* and *Starch*, *Marlin*, *Twine*, *Nails*, *Hand-spikes*, *Crows* of *Iron*, *Granado-shells*, and Materials for Composition, *Fasces*, *Budg-Barrels*, *Cannon-Baskets*, &c. These being general things he is to know, and at all times to have ready by him,and he is more particularly to know these following parts of his Art: As,

PROP. I.

How to Tertiate, Quadrate, and to Dispart a Piece of Ordnance.

1. *To Tertiate a Piece*, is to find whether it hath its due thickness at the *Trunnions*, *Touch-hole*, and *Neck*; if the *Trunnions*, and the *Neck* are in its due order, and the *Chase streight*.

2. *To Quadrate a Piece* mounted, is to see whether it be directly placed, and equally poized in the Carriage; which is known by finding in the *Convex Superficies* of the *Base*, and *Muzzel Ring*; the point which is *Perpendicular*, over the *Soul* of the *Piece*: which may be found by the Gunners Instrument, called a *Level*; an Instrument whose use is so vulgarly known, that it needeth not my Explanation.

3. To *Dispart* a Piece, is to fix, or elevate on the Convex point of the *Muzzel Ring*, a Mark, as far distant from the *Cylinder*, or Soul of the Piece, as is the point of the *Base-Ring*; to the end, that the *Visail-ray* which passeth by these marks, may be *Parallel* to the *Chase*, *Soul*, or *Cy-*

Cylinder of the Piece. Now the *Dispart*, i. e. the difference of the *Semidiameters* of the *Cornishes*, may be by a pair of *Calliper Compasses* attained. Which found, place on the Top of the *Cornish-Ring*, near the *Muzzel*, over the middle of the *Inferior Cylinder*. §. 3.

PROP. II.

To know how far any Piece of Ordnance will shoot, &c.

As to the several shootings in *Artillery*, Authors differ much in their Judgments, and Opinions, but they all unanimously agree that the *Ball* being shot forth flies through the Air, with a *Violent*, *Mixt* and *Natural* motion; describing a *Parabolical line*, in whose beginning and ending are lines sensibly streight, and in the middle carved: In the beginning the Imprest force driving forward by the Fire, the *Natural* gravity of the *Ball* doth describe a *Right-line*, called the *Direct line*, or *Rangs* of the *Ball's Circute*. *Fig.* 92.

In the middle that force diminisheth, and the *Natural Gravity* prevaileth, so that it describeth a curved line, called the *Ball's middle Helical* or *Conical Arch* *; In the End the *Natural Gravity* overcoming the Imprest violence, (which becomes altogether weak and faint) describes a new right line, called the *Ball's declining line*, in which the *Ball* tends towards the Center of the Earth, as towards a Place natural unto all heavy bodies: See Figure the 92. These motions are somewhat longer, according as the Piece is mounted

* See Mr. Diggs *in his* Pantometria, *page* 179.

§. 3. mounted from the level unto the Angle of 45 deg. which is called the *Utmost Random*: The Elevation of which, is regulated by the *Gunners Quadrant*, the Use of which Instrument is so generally known, and by so many Authors fully explained, that I here crave leave to omit it: But take these for General Rules.

General Rules to be observed in the battering down of a Place, or making of Breaches.

1. *That a Shoot at Right Angle, strikes more violent and furiously than at Oblique Angles, therefore Gunners use when they are to batter down a Tower, Wall, or Earth-work, to shoot point blank at the Object, Tire by Tire; by discharging all the Pieces in Battery against the self same Object, in the same Instant,* holding it for a Maxim, *that ten Cannons discharged together, do far more Execution than discharged one after another.* Now at *Oblique Angles* they shoot either Cross-ways or by rebounding.

2. *That the speediest way to make a Breach in a Wall,* &c. *Is by shooting at the Object from two Batteries, which ruins far more speedily than by striking the Object, with one Battery, at Right Angles, although that one Battery, hath as many Cannon as the other* two hath.

3. *That if you were to batter a Flank, covered with an Orillion, (which because you cannot possibly batter it right forward) you must therefore of necessity batter it Obliquely, by way of Rebounding,* thus: Chuse a fit place in the *Curtain* to be your *Object*, on which you may play with your *Battery* obliquely, so that by a rebound the shoot may leap into the *Flanks*, holding for a *Maxim*, in this operation, * *That the Angles of Incidence and Reflection are Equal.*

* *According to learned* D' Chales, *on the 4th Prop. of the first Book of* Euclid.

Now we come to shew the length of the *Right*

Right Range, of all our Common English *Ordnance*, which is set down in the precedent Table, in which the *Cannon* exceed not 185 *Paces*, *&c.* Esteeming the Pace 5 English Feet, nor his *utmost Random* above 1850 Paces, which Table so sheweth for all other Natures. §. 3.

As for the *Ranges*, and *Randoms*, to the *several Degrees* and points of Mounture of the *Quadrant*, I have hereunto annexed the Tables, calculated by the Experiments of sundry most Eminent Artists, whose Works will perpetuate their Worth and Name to succeding Generations.

A Table of Ranges, and Randoms, to the several Degrees of Mounture of the Quadrent.

A TABLE OF

Right Ranges or Points Blanks.		*Randoms or the First Graze.*	
The Degrees of the Pieces Mounture.	*The Right Range in Paces of 5 Feet.*	*The Degrees of Mounture.*	*The Paces of the Random 5 Feet a Pace.*
0	192	0	192
1	209	1	298
2	227	2	404
3	249	3	510
4	261	4	610
5	278	5	722
6	285	6	828
7	302	7	934
8	320	8	1044
9	337	9	1129
10	354	10	1214
20	454	20	1917
30	693	30	2185
40	855	40	2289
50	1000	50	2283
60	1140	60	1792
70	1220	70	1214
80	1300	80	1000
90	1350	90	

§. 3.

The Use of the Table of Randoms.

This Table is most agreeing to *Cannons*, and *Culverins*, and the greatest sort of *Ordnance*, the Use thereof is thus.

Admit a *Saker* to be mounted to 3 deg. shoots the Bullet 323 *Paces*, how far will it shoot being mounted unto 7 *deg.* Say (*by prop.* 1. *chap.* 1.)

As 510 the Tabular distance for 3 deg. of Mounture, to 323, the distance found,

So is 934 the Tabular distance for 7 deg. of Mounture, to $591\frac{272}{510}$, the distance required, which the *Saker* according to this Experiment shall shoot at 7 deg. of Mounture.

Mr. *NYE* in his Book of Gunnery printed *Anno*, 1647, saith he made an Experiment by a *Saker* of 8 Feet long, which he loaded with three pounds of *Powder*, of an exact weight, both *Powder* and *Wad* at every charge, every time ramming it down with three equal stroaks, as near as possible; but on the *Bullet* he put no *Wad*, because the *Saker* was mounted; And thus he made four Shoots, each of them half an Hour after the other, that so the Piece might be of equal temper, and mounted his Piece to these 4 degrees of Mounture, *viz.* 1 deg. 5 deg. 7 deg. 10 deg. and found these Randoms.

At 1 *Deg. the Random* was	225	*Paces.*
At 5 *Deg. the Random* was	416	
At 7 *Deg. the Random* was	505	
At 10 *Deg. the Random* was	630	

Accor-

According to which Experiment, he framed this Table of *Randoms*. §. 3.

Deg.	*Paces*	*Deg.*	*Paces*
0	206	6	461
1	225	7	505
2	274	8	548
3	323	9	589
4	370	10	630
5	416		

Captain HEXAM in his Book of *Gunnery*, shews how by finding out the *Random* of a *Cannon*, for the first Degree of Mounture, thereby to find the *Random* for every Degree to 45 deg. or utmost Random, and this is his Rule to perform it. First find how many Paces the *Cannon* will shoot being laid level by the Metal, (which by him is accounted 1 deg.) Then divide the distance found, by 50, then multiply the Quotient by 11, so shall the product be the greatest *Digression*, or *Difference* betwixt *Rangs*, and *Rang*; which being divided by 44, the Quotient giveth the Number of *Paces*, which the *Bullet* will *lose* in the other *Rangs*, from *Degree*, unto *Degree*; according to this Rule, this Table is calculated.

A Table

§. 3.

A Table of Randoms to 45 Degrees, accounting a Pace 2 ½ Foot.

D. Moun	Paces.	Diff.	D. Moun.	Paces.	Diff.
0	0775	225	23	4685	110
1	1000	220	24	4795	105
2	1220	215	25	4900	100
3	1435	210	26	5000	95
4	1645	205	27	5095	90
5	1850	200	28	5185	85
6	2050	195	29	5270	80
7	2245	190	30	5350	75
8	2435	185	31	5425	70
9	2620	180	32	5595	65
10	2800	175	33	5560	60
11	2975	170	34	5620	55
12	3145	165	35	5675	50
13	3310	160	36	5725	45
14	3470	155	37	5770	40
15	3625	150	38	5810	35
16	3775	145	39	5845	30
17	3920	140	40	5875	25
18	4060	135	41	5900	20
19	4595	130	42	5920	15
20	4325	125	43	5935	10
21	4450	120	44	5945	5
22	4570	115	45	5950	

I have

I have hereunto also annexed the Table calculated by *Alexander Bianco*, for all sort of Ordnance, (which Table I account one of the best that was ever yet found Extant) In his Work printed 1648. §. 3.

A Table of Randoms for the first six Points of the Gunner's Quadrant.

Points.	1	2	3	4	5	6
Falconet.	375	637	795	885	832	900
Falcon.	550	935	1166	1254	1309	1320
Minion.	450	765	954	1026	1071	1080
Saker.	625	1062	1325	1125	1487	1500
Demi-culver.	725	1232	1537	1653	1725	1740
Culverin.	750	1275	1590	1710	1785	1800
Demi-cannon.	625	1062	1325	1425	1487	1500
Cannon of 7.	675	1147	1431	1489	1606	1620
Double Cannon.	750	1275	1590	1710	1785	1800

SECT. IV.

Of Shooting in Mortar-Pieces. §. 4.

A *Mortar-Piece* is a short Piece, with which they shoot *Bombs*, *Granado-Shells*, *Stone-Balls*, &c. not by a Right line but from a Curved, from on high; so that it may fall where it

§. 4. ſhould be deſired: Now this *Mortar* is placed in the *Carriage*, in all reſpects as you ſee in Fig.
Fig. 93. 93. in which A ſignifies the *Carriage*, B the *Mortar*, C the *Courſe the ſhoot flies*, and D the *Place* on which it falls.

Bombs are great hollow Balls of *Iron*, or *Braſs*, in which are put fine *Sifted Gun-Powder*, which by a *Fuſe*, they proportion to them a due Fire, that ſo they may break aſſoon as they fall amongſt the Enemies. Theſe *Fuſes* are ſmall Trunks of *Wood*, *Tinn*, or *Iron*, filled with a *prepared Compoſition* for that purpoſe. *Granadoes* are of the ſame form with *Bombs*, only ſmaller, and many times are caſt by hand, and are made of *Iron*, *Braſs*, *Glaſs*, or *Earth*.

Now in Order to the well ſhooting in thoſe kind of *Machines* called *Mortars*, 'tis requiſite to obſerve theſe following Rules: as,

1. *That before you make a ſhoot at any Place, you find the diſtance thereof from your Mortar, which may be obtained by Prop.* 3. §. 4. *Chap.* 9.

2. *That the Bombs, or other Bodies that are to be ſhot, be of equal weight, otherwiſe the ſhoots will vary*

3 *That the Carriage in breadth be always on a Level, and without any deſcent, that ſo it may not leap in diſcharging.*

4. *That the Powder with which the Mortar is loaded, be always of the ſame force and weight.*

5. *That the Charge of the Mortar, as well in Powder as in Wadding, be always rammed in with blows equally heavy, and of equal number.*

6 *That the Wadds be always either of Wood, or Tampeons, or elſe of Okam, for the ſtrongeſt drives it fartheſt.*

7. *That*

7. That the Fuses be newly made, in those days that they are to be used, and that they be made of a Composition proportionable to the Range that the shoot shall make in the Air, so that the Bomb may break in the very moment of its fall; which Composition must be such, that though it fall in the Water, yet not to extinguish, but the Bomb there to break. Now before we proceed any farther, I think it necessary, to shew how to compose your Ingredients for your *Fuse*. §. 4.

PROP. I.

To make Fuses for Bombs, &c.

The Composition for *Bombs* must be of a slow motion, that so time enough may be given to throw either *Bombs*, *Granadoes*, *Fire-balls*, *Thundring-Barrels*, &c. They are compounded of these Ingredients, thus: Take a pound of *Gun-Powder*, $\frac{4}{16}$ of *Sulphur*, $\frac{4}{16}$ of *Salt-Peter*, well beaten, dry, and sifted separately, then mix it, and make up your *Fuse* thereof: Or take Powder of *Benjamin*, and *Small-Coles*, all well beaten and mixed together with some *Oyl of Piter*, and so fill your *Fuse* therewith.

Now the use of *Mortar-Pieces*, being for the most part to shoot up at *Random*, therefore the *Randoms* of these Pieces is very necessary to be known: Therefore hereunto I have annexed the Tables of *Randoms*, calculated by the Experience of the best of Authors, which have wrote on this Subject; most of which do agree in their *Randoms*, although they are in a several dress:

§. 4. *Diego-Uffano-Zutphen* in his Works printed 1621, hath calculated these two following Tables, the one for the 12 points of the *Quadrant*, the other for every *Degree*, taking the one Half of each Number, and so 'tis reduced into our English Paces of 5 Feet, which Tables were esteemed and made use of, both by Captain *Hexam*, and Mr. *Norton*, and are as followeth.

A Table of Randoms for Mortar-Pieces, to the 12 Points of the Gunner's Quadrant, calculated by Diego-Uffano-Zutphen.

583	570	534	468	377	248	100	
6	5	4	3	2	1	0	
:	•	:	•	•	•	•	⊙
6	7	8	9	10	11	12	
583	570	534	468	377	248	000	

Now suppose the *Mortar* to be placed at ⊙, the Pricks in the middle line representeth the several *Randoms*, numbred with the Degrees of the *Quadrant*, forward and backward, unto which the several Randoms are set; so you see that the *Mortar* being levelled point blank, throweth the *Bomb* 100 *Paces*, if the *Mortar* be mounted one Point, it throws the *Bomb* 248 Paces, &c. untill 'tis mounted to the 6th. point,

583 *Paces*,

583 *Paces*, which is the utmost Random : Now §. 4.
if the *Mortar* be mounted higher to 7, 8, 9, *&c.* Points, the *Randoms* decreaſe again as before they did increaſe: as you ſee in the *Table.*

But in thoſe latter *Randoms* there lieth a great miſtake, as ſhall be made palpably appear. For if as they are diſtant from the ſixth Point you make them equal to one another, then the Random of the 12 points, muſt be equal to the Random of 0 point, or the *Level Random*, which is 100 Paces from the Mortar. Now it is contrary to all Art and Reaſon, to think that if the *Mortar* be elevated to the 12*th.* point, *i.e.* bolt upright, it ſhould ſhoot the Bomb 100 Paces from the *Mortar*; no, it cannot be; but according to all Reaſon the *Bomb* muſt fall down either on, or near the *Mortar*, and not 100 Paces diſtant, as is moſt erroneouſly conceived; the like errour is in the following Table of our ſaid Author; but becauſe Mr. *Phillipps* in his *Mathematical Manual* hath amply demonſtrated their Errours, I therefore ſhall ſay no more to the Errours that have been a long time generally conceived and embraced as a truth, but now are removed.

A Table

§. 4.

A Table of Randoms for Mortar-Pieces, to every Degree of the Quadrant.

The Degrees of Mounture.	The Paces of the Random.	The Degrees of Mounture.	The Degrees of Mounture.	The Paces of the Random.	The Degrees of Mounture.
0	100	89	23	480	66
1	122	88	24	490	65
2	143	87	25	500	64
3	164	86	26	510	63
4	185	85	27	518	62
5	204	84	28	525	61
6	224	83	29	531	60
7	243	82	30	536	59
8	263	81	31	540	58
9	280	80	32	543	57
10	297	79	33	549	56
11	315	78	34	552	55
12	331	77	35	558	54
13	347	76	36	562	53
14	362	75	37	568	52
15	377	74	38	573	51
16	393	73	39	577	50
17	406	72	40	580	49
18	419	71	41	581	48
19	432	70	42	582	47
20	445	69	43	583	46
21	457	68	44	584	
22	460	67	45	585	

The moſt exact Tables of Randoms for the *Mortar*, that I have ſeen or can find in any Ancient, or Modern Author, is this following Table, calculated by the experience and trial of that Famous Inginier *Tomaſo Moretii* of *Breſcia*, Inginier to the moſt ſerene *Republique of Venice*, in his Works Intituled, *Trattatu delle Artiglieria*, printed 1665. Where he ſuppoſeth the utmoſt

Random

Random, equal to 10000, according to which §. 4.
proportion he framed this following Table.

A Table of the ſeveral Randoms of each Degree of the Quadrant, the greateſt Equal to 10000.

Elev.		Elev.	Elev.		Elev.
1°	349	89°	23°	7193	67°
2	698	88	24	7431	66
3	1045	87	25	7660	65
4	1392	86	26	7880	64
5	1736	85	27	8090	63
6	2079	84	28	8290	62
7	2419	83	29	8480	61
8	2756	82	30	8660	60
9	3090	81	31	8829	59
10	3420	80	32	8988	58
11	3746	79	33	9135	57
12	4067	78	34	9272	56
13	4384	77	35	9397	55
14	4695	76	36	9511	54
15	5000	75	37	9613	53
16	5299	74	38	9703	52
17	5592	73	39	9781	51
18	5870	72	40	9848	50
19	6157	71	41	9903	49
20	6428	70	42	9945	48
21	6691	69	43	9976	47
22	6947	68	44	9994	46
			45	10000	45

The Uſe of the Precedent Table is explained by theſe following Propoſitions.

PROP. II.

Finding that a Mortar of 300, *with a Tampeon of Wood, being elevated* 45°, *or* 6 *Points of the Quadrant, ſends a Bomb* 800 *Paces, how many Paces ſhall the ſame ſhoot, at the Elevation of* 54°?

Look at the ſaid 54° of the Table, and you *Demon-*
will *ſtration.*

§. 4. will find the proportional Number 9511, to correspond thereunto. Now you find the proportional Number belonging to 45° is 10000, then by *Prop.* 1. *Chap.* 1. Say as 10000, to 800, so is 9511, to $760\frac{88}{100}$, which are the *Paces*, the *Mortar* will send the *Bomb* at the *Elevation of* 54 *Degrees.*

PROP. III.

Finding that a Mortar of 300, *being elevated* 54°, *sends his Bomb* $760\frac{88}{100}$ *Paces, what Degree of Elevation must that Mortar have, to shoot the Bomb* 555 *Paces?*

This is but the Converse of the former, therefore (according to *Prop.* 1. *Chap.* 1.) say, as $760\frac{88}{100}$ *Paces*, gives the proportional part or number 9511; so doth 555 *Paces*, give the proportional part 6945. Which number sought among the proportional Numbers, in the Table, you will find 68 *Degrees* to correspond to that proportional Number 6945, so that the *Mortar* must be elevated to 68 *Degrees* to shoot the *Bomb* 555 *Paces*, which was required to be known These Rules and Precepts here delivered, I esteem necessary to be known by every *Gunner*, who intends to be serviceable for his *Prince* and *Countrey.*

Vive, vale: Siquid novisti rectius istis,
Candidus imperti: Si non his utere mecum.

Hora. *lib.* 1. *Epist.*

FINIS.

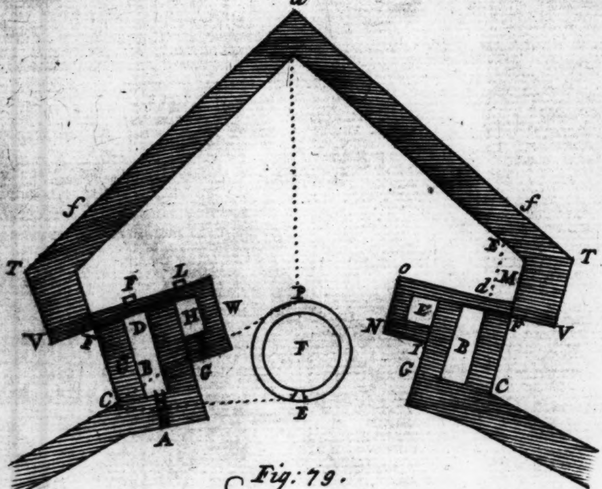
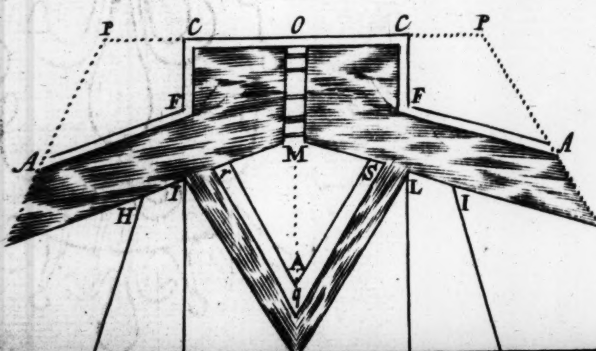


Fig: 79.

Figure 80.



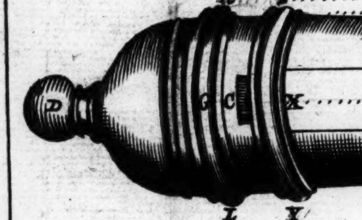
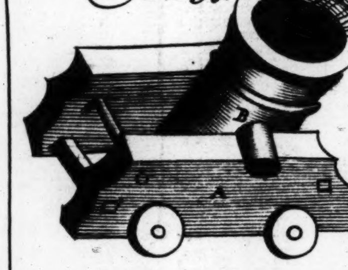


Figure 93.



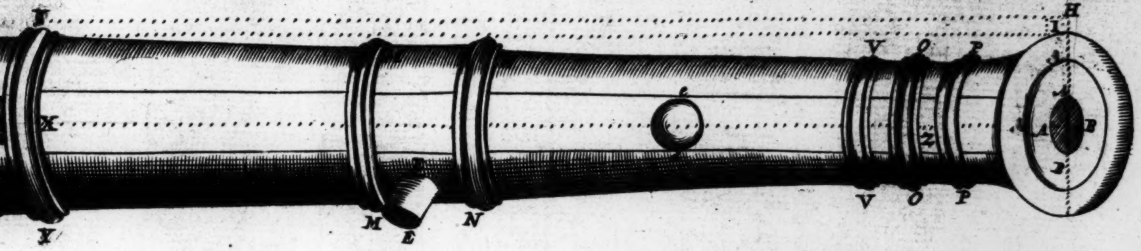
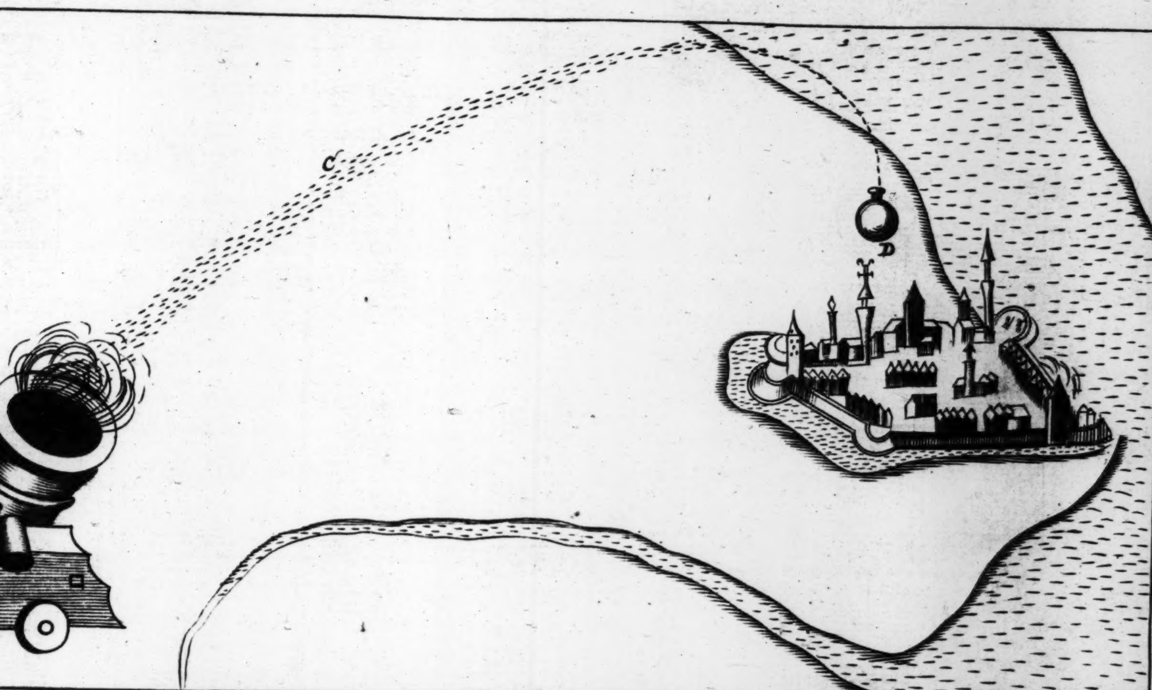


Figure 91



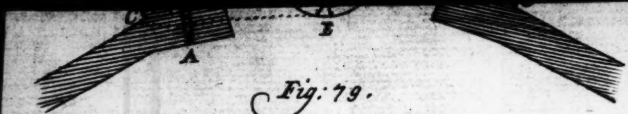
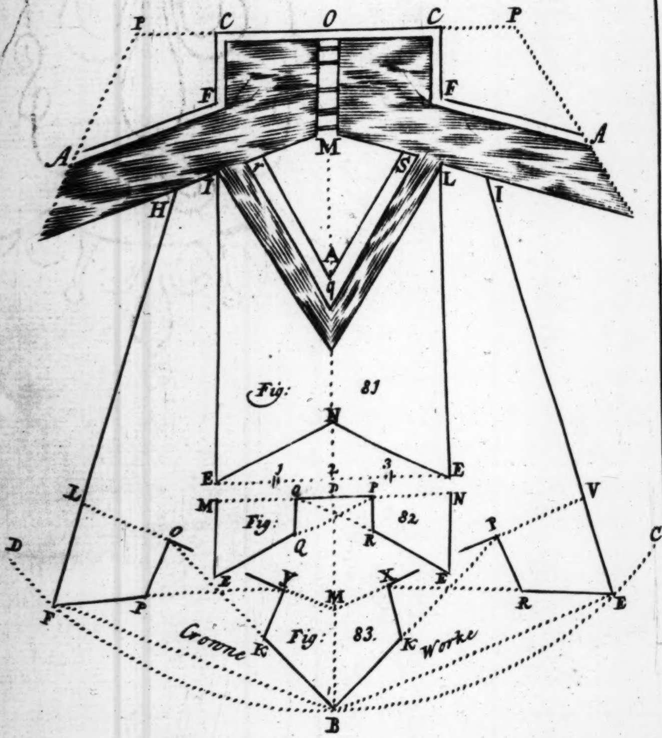


Fig: 79.

Figure 80.



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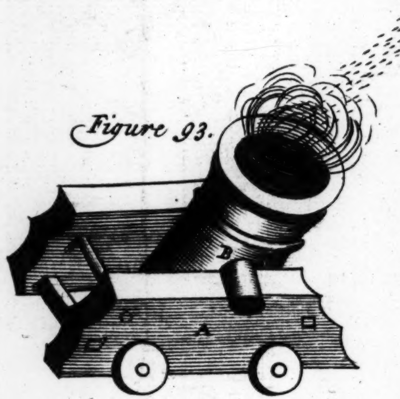
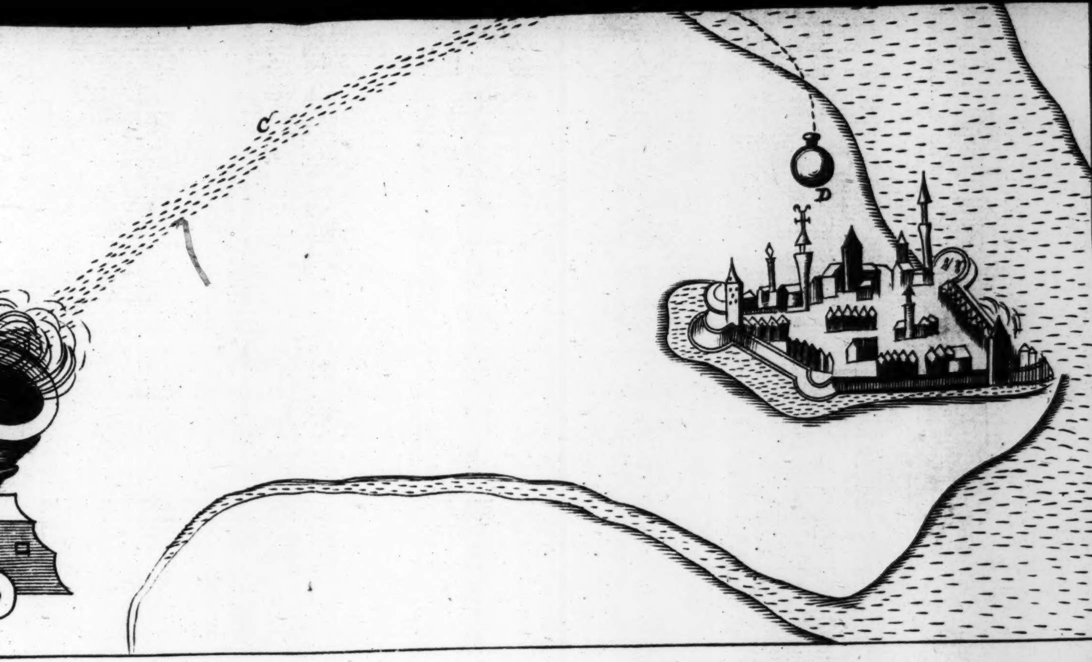
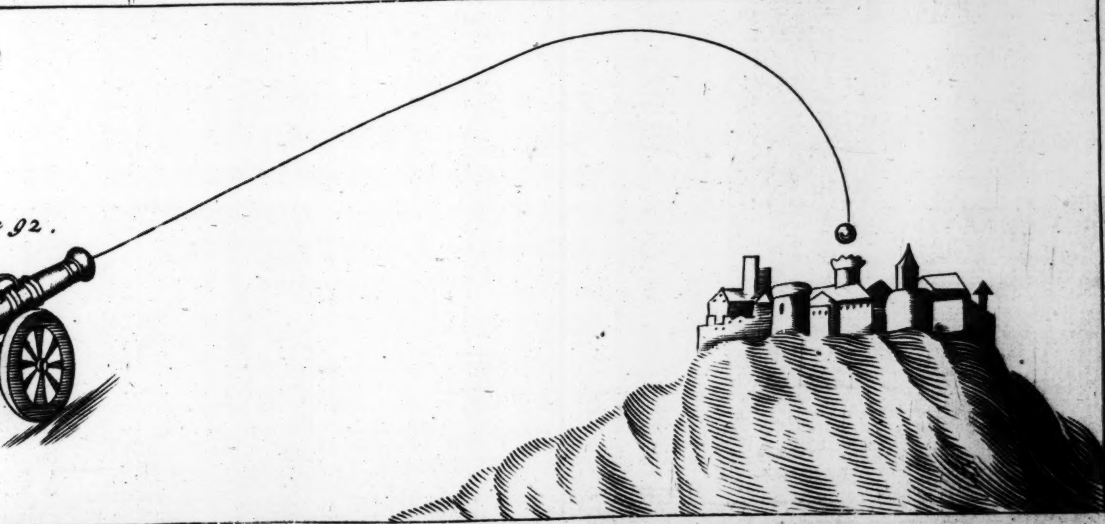


Figure 92.


C
D


92.

A
TABLE
OF
Logarithm Numbers,
From One to Ten Thouſand:
Whereby the
LOGARITHM
OF ANY
NUMBER
Under Four Hundred Thouſand may be readily diſcovered.

LONDON,
Printed by *J. Heptinſtall* for *W. Freeman*, at the *Artichoke* next St. *Dunſtan*'s Church in *Fleetſtreet*. MDCLXXXVII.

N	Log.	N	Log.	N	Log.
1	0. 000000	34	1.531479	67	1. 826075
2	0. 301030	35	1.544068	68	1. 832509
3	0. 477121	36	1.556303	69	1. 838849
4	0. 602060	37	1.568202	70	1. 845098
5	0. 698970	38	1.579783	71	1. 851258
6	0. 778151	39	1.591064	72	1. 857332
7	0. 845098	40	1.602060	73	1. 863323
8	0. 903090	41	1.612784	74	1. 869232
9	0. 954242	42	1.623249	75	1. 875061
10	1. 000000	43	1.633468	76	1. 880813
11	1. 041393	44	1.643452	77	1. 886491
12	1. 079181	45	1.653212	78	1. 892094
13	1. 113943	46	1.662758	79	1. 897627
14	1. 146128	47	1.672098	80	1. 903090
15	1. 176091	48	1.681241	81	1. 908485
16	1. 204120	49	1.690196	82	1. 913814
17	1. 230449	50	1.698970	83	1. 919078
18	1. 255272	51	1.707570	84	1. 924279
19	1. 278753	52	1.716003	85	1. 929419
20	1. 301030	53	1.724276	86	1. 934498
21	1. 322219	54	1.732394	87	1. 939519
22	1. 342422	55	1.740362	88	1. 944482
23	1. 361728	56	1.748188	89	1. 949390
24	1. 380211	57	1.755875	90	1. 954242
25	1. 397940	58	1.763428	91	1. 959041
26	1. 414973	59	1.770852	92	1. 963788
27	1. 431364	60	1.778151	93	1. 968483
28	1. 447158	61	1.785330	94	1. 973128
29	1. 462398	62	1.792391	95	1. 977723
30	1. 477121	63	1.799340	96	1. 982271
31	1. 491361	64	1.806180	97	1. 986772
32	1. 505150	65	1.812913	98	1. 991226
33	1. 518514	66	1.819544	99	1. 995635

N	0	1	2	3	4
100	000000	000434	000868	001301	001734
101	004321	004751	005181	005609	006038
102	008600	009026	009451	009876	010299
103	012837	013259	013679	014100	014521
104	017033	017451	017898	018284	018700
105	021189	021603	022016	022428	022841
106	025306	025715	026125	026533	026942
107	029384	029789	030195	030599	031004
108	033424	033826	034227	034628	035029
109	037426	037825	038223	038620	039017
110	041393	041787	042182	042576	042969
111	045323	045714	046105	046495	046885
112	049218	049603	049993	050379	050766
113	053078	053463	053846	054229	054613
114	056905	057286	057666	058046	058426
115	060698	061075	061452	061829	062206
116	064458	064832	065206	065579	065953
117	068186	068557	068928	069298	069668
118	071882	072249	072617	072985	073352
119	075547	075912	076276	076640	077004
120	079181	079543	079904	080266	080626
121	082785	083144	083503	083861	084219
122	086359	086716	087071	087426	087781
123	089905	090258	090610	090963	091315
124	093422	093772	094122	094471	094820
125	096910	097257	097604	097951	098298
126	100371	100715	101059	101403	101747
127	103804	104146	104487	104828	105169
128	107209	107549	107888	108227	108565
129	100589	100926	111263	111599	111934

5	6	7	8	9	D
002166	002598	003029	003461	003891	432
006466	006894	007321	007748	008174	428
010724	011147	011570	011993	012415	424
014940	015359	015779	016197	016616	416
019116	019532	019947	020361	020775	416
023252	023664	024075	024486	024896	412
027349	027757	028164	028371	028978	408
031408	031812	032216	032619	033021	404
035429	035829	036229	036629	037028	400
039414	039811	040207	040602	040998	396
043362	043755	044148	044539	044932	393
047275	047664	048053	048442	048830	389
051153	051538	051924	052309	052694	386
054996	055378	055760	056142	056524	382
058805	059185	059563	059942	060320	379
062582	062958	063333	063709	064083	376
066326	066699	067071	067443	067815	372
070038	070407	070776	071145	071514	369
073718	074085	074451	074816	075182	366
077368	077731	078094	078457	078819	363
080987	081347	081707	082067	082426	360
084576	084934	085291	085647	086004	357
088136	088490	088845	089198	089552	355
091667	092018	092369	092721	093071	351
095169	095518	095866	096215	096562	349
098644	098989	099335	099681	100026	346
102091	102434	102777	103119	103462	343
105510	105851	106191	106531	106871	340
108903	109241	109579	109916	110253	338
112269	112605	112939	113275	113609	335

N	0	1	2	3	4
130	113943	114277	114611	114944	115278
131	117271	117603	117934	118265	118595
132	120574	120903	121231	121559	121888
133	123852	124178	124504	124830	125156
134	127105	127429	127753	128076	128399
135	130334	130655	130977	131298	131619
136	133539	133858	134177	134496	134814
137	136721	137037	137354	137671	137987
138	139879	140194	140508	140822	141136
139	143015	143327	143639	143951	144263
140	146128	146438	146748	147058	147367
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703	846955	847017	847079	847141	847202
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705	848189	848251	848312	848374	848435
706	848805	848866	848928	848989	849051
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718	856124	856185	856245	856306	856366
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883	945961	946009	946059	946108	946157
884	946452	946501	946551	946599	946649
885	946943	946992	947041	947090	947139
886	947434	947483	947532	947581	947629
887	947924	947973	948022	948070	948119
888	948413	948462	948511	948559	948609
889	948902	948951	948999	949048	949097
890	949390	949439	949488	949536	949585
891	949878	949926	949975	950024	950073
892	950365	950414	950462	950511	950559
893	950851	950900	950949	950997	951046
894	951338	951386	951435	951483	951532
895	951823	951872	951920	951969	952017
896	952308	952356	952405	952453	952502
897	952792	952841	952889	952938	952986
898	953276	953325	953373	953421	953469
899	953759	953808	953856	953905	953953
900	954243	954292	954339	954387	954435
901	954725	954773	954821	954869	954918
902	955207	955255	955303	955351	955399
903	955688	955736	955784	955832	955880
904	956168	956216	956265	956313	956361
905	956649	956697	956745	956793	956840
906	957128	957176	957224	955272	957319
907	957607	957655	957703	957751	957799
908	958086	958134	958181	958229	958277
909	958564	958612	958659	958707	958755

5	6	7	8	9	D
944729	944779	944828	944877	944927	49
945222	945272	945321	945370	945419	49
945715	945764	945813	945862	945912	49
946207	946256	946305	946354	946403	49
946698	946747	946796	946845	946894	49
947189	947238	947287	947336	947385	49
947679	947728	947777	947826	947875	49
948168	948217	948266	948315	948364	49
948657	948706	948755	948804	948853	49
949146	949195	949244	949292	949341	49
949633	949683	949731	949780	949829	49
950121	950170	950219	950267	950316	49
950608	950657	950706	950754	950803	49
951095	951143	951192	951240	951289	49
951580	951629	951677	951729	951775	49
952066	952114	952163	952210	952259	49
952550	952399	952647	952696	952744	48
953034	953083	953131	953179	953228	48
953518	953566	953615	953663	953711	48
954001	954049	954099	954146	954194	48
954484	954532	954580	954628	954677	48
954966	955014	955062	955110	955158	48
955447	955495	955543	955592	955639	48
955928	955976	956024	956075	956120	48
956409	956457	956505	956533	956601	48
956888	956936	956984	957032	957080	48
957368	957416	957464	957512	957559	48
957847	957894	957942	957900	958038	48
958325	958373	958421	958468	958516	48
958803	958850	958898	958946	958994	48

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910	959041	959089	959137	959185	959231
911	959518	959566	959614	959661	959709
912	959995	960042	960090	960138	960185
913	960471	960518	960566	960613	960661
914	960946	960994	961041	961089	961136
915	961421	961469	961516	961563	961611
916	961895	961943	961990	962038	962085
917	962369	962417	962464	962511	962559
918	962842	962886	962937	962985	963032
919	963315	963363	963410	963457	963504
920	963788	963835	963882	963929	963977
921	964259	964307	964354	964401	964448
922	964731	964778	964825	964872	964919
923	965202	965249	965296	965343	965389
924	965672	965719	965766	965813	965859
925	966142	966189	966239	966283	966329
926	966611	966658	966705	966752	966799
927	967079	967127	967173	967220	967267
928	967548	967595	967642	967688	967735
929	968016	968062	968109	968156	968202
930	968483	968529	968576	968623	968669
931	968949	968996	969043	969089	969136
932	969416	969463	969509	969556	969602
933	969882	969928	969975	970021	970068
934	970347	970393	970439	970486	970533
935	970812	970858	970904	970951	970997
936	971286	971322	971369	971415	971461
937	971739	971786	971832	971879	971925
938	972203	972249	972295	972342	972388
939	972666	972712	972758	972804	972851

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959279	959328	959375	959423	959471	48
959757	959804	959852	959899	959947	48
960233	960280	960328	960376	960423	48
960709	960756	960804	960851	960899	48
961184	961231	961279	961326	961374	47
961658	961706	961753	961801	961848	47
962132	962179	962227	962275	962322	47
962606	962653	962701	969748	962795	47
963079	963126	963174	963221	963268	47
963552	963599	963646	963693	963741	47
964024	964071	964118	964165	964212	47
964495	964542	964589	964637	964684	47
964966	965013	965061	965108	965155	47
965437	965484	965531	965578	965624	47
965906	965954	966001	966048	966095	47
966376	966423	966470	966517	966564	47
966845	966892	966939	966986	967033	47
967314	967361	967408	967454	967501	47
967782	967829	967875	967922	967969	47
968249	968296	968343	968389	968436	47
968716	968763	968809	968856	968902	47
969183	969229	969276	969323	969369	47
969649	969695	969741	969789	969835	47
970114	970161	970207	970254	970300	47
970579	970626	970672	970719	970765	46
971044	971090	971137	971183	971229	46
971508	971554	971601	971647	971693	46
971971	972018	972064	972110	972157	46
972434	972481	972527	972573	972619	46
972897	972943	972989	973035	973082	46

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940	973128	973174	973220	973266	973313
941	973589	973636	973682	973728	973774
942	974050	974097	974143	974189	974235
943	974512	974558	974604	974649	974695
944	974972	975018	975064	975109	975156
945	975432	975478	975524	975569	975616
946	975891	975937	975983	976029	976075
947	976349	976396	976442	976488	976533
948	976808	976854	976899	976946	976992
949	977266	977312	977358	977403	977449
950	977724	977769	977815	977861	977906
951	978181	978226	978272	978317	978363
952	978637	978683	978728	978774	978819
953	979093	979138	979184	979229	979275
954	979548	979594	979639	979685	979730
955	980003	980049	980094	980139	980185
956	980458	980503	980549	980594	980639
957	980912	980957	981003	981048	981093
958	981366	981411	981456	981501	981547
959	981819	981864	981909	981954	981999
960	982271	982316	982362	982407	982452
961	982723	982769	982814	982859	982904
962	983175	983220	983265	983310	983356
963	983626	983671	983716	983762	983807
964	984077	984122	984167	984212	984257
965	984527	984572	984617	984662	984707
966	984977	985022	985067	985112	985157
967	985426	985471	985516	985561	985606
968	985875	985920	985965	986009	986055
969	986324	986369	986413	986458	986504

5	6	7	8	9	D
973359	973405	973451	973497	973543	46
973820	973866	973913	973959	974005	46
974281	974327	974374	974419	974466	46
974742	974788	974834	974819	974926	46
975202	975248	975294	975339	975386	46
975662	975707	975753	975799	975845	46
976121	976167	976212	976258	976304	46
976579	976625	976671	976717	976763	46
977037	977083	977129	977175	977220	46
977495	977541	977586	977632	977678	46
977952	977998	978042	978089	978135	46
978409	978454	978500	978546	978591	46
978865	978911	978956	979002	979047	46
979321	979366	979412	979457	979503	46
979776	979821	979867	979912	979958	46
980231	980276	980322	980367	980412	45
980685	980730	980776	980821	980867	45
981139	981184	981229	981275	981320	45
981592	981637	981683	981728	981773	45
982045	982090	982135	982181	982226	45
982497	982543	982588	982633	982678	45
982949	982994	983039	983085	983129	45
983401	983446	983490	983536	983581	45
983852	983897	983942	983987	984032	45
984302	984347	984392	984437	984482	45
984752	984797	984842	984887	984932	45
985202	985247	985292	985337	985382	45
985651	985696	985741	985786	985830	45
986099	986144	986189	986234	986279	45
986548	986593	986637	986682	986727	45

N	0	1	2	3	4
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971	987219	987264	987309	987353	987398
972	987666	987711	987756	987800	987845
973	988113	988157	988202	988247	988291
974	988559	988604	988748	988693	988737
975	989005	989049	989094	989138	989183
976	989449	989494	989539	989584	989628
977	989895	989939	989983	990028	990072
978	990339	990383	990428	990472	990516
979	990783	990827	990871	990916	990960
980	991226	991270	991315	991359	991403
981	991669	991713	991758	991802	991846
982	992111	992156	992199	992244	992288
983	992554	992598	992642	992686	992730
984	992995	993039	993083	993127	993172
985	993436	993480	993524	993568	993613
986	993877	993921	993965	994009	994053
987	994317	994361	994405	994449	994493
988	994756	994801	994845	994889	994933
989	995196	995240	995284	995328	995372
990	995635	995679	995723	995764	995811
991	996074	996117	996161	996205	996249
992	996512	996555	996599	996643	996687
993	996949	996993	997037	997080	997124
994	997386	997430	997474	997517	997561
995	997823	997867	997910	997954	997998
996	998259	998303	998347	998390	998434
997	998695	998739	998783	998826	998869
998	999133	999174	999218	999261	999305
999	999565	999609	999652	999696	999739

5	6	7	8	9	D
986996	987040	987085	987129	987175	45
987443	987488	987532	987577	987622	45
987889	987934	987979	988024	988068	45
988336	988381	988425	988469	988514	45
988782	988826	988871	988916	988960	45
989227	989272	989316	989361	989405	45
989672	989717	989761	989806	989850	44
990117	990161	990206	980150	990294	44
990561	990605	990649	990694	990738	44
991004	991049	991093	991137	991182	44
991448	991492	991536	991580	991625	44
991890	991935	991979	992023	992067	44
992333	992377	992421	992465	992509	44
992774	992819	992863	992907	992951	44
993216	993259	993304	993348	993392	44
993657	993701	993745	993789	993833	44
994097	994141	994185	994229	994273	44
994537	994581	994625	994669	994713	44
994977	995021	995065	995108	995152	44
995416	995459	995504	995547	995591	44
995854	995898	995942	995986	996029	44
996293	996337	996380	996424	996468	44
996731	996774	996818	996862	996906	44
997168	997212	997255	997299	997343	44
997605	997648	997692	997736	997779	44
998041	998085	998129	998170	998216	44
998477	998521	998564	998608	998652	44
998913	998956	998959	999043	999087	44
999348	999392	999435	999479	999522	44
999783	999826	999869	999913	999957	43

A TABLE OF PROPORTIONAL PARTS,

WHEREBY

The *Intermediate Logarithms* of all Numbers,

AND

The Numbers of all *Logarithms* from 10000 to 100000 may more readily be found out by the foregoing Table of *Logarithms.*

LONDON,

Printed by *J. Heptinstall* for *W. Freeman*, at the *Artichoke* next St. *Dunstan's* Church in *Fleetstreet.* MDCLXXXVII.

T

P

D
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
61
62

TABLE

OF

Proportional Parts.

D	1	2	3	4	5	6	7	8	9
43	4	8	12	17	21	25	30	34	38
44	4	8	13	17	22	26	30	35	39
45	4	9	13	18	22	27	31	36	40
46	4	9	13	18	23	27	32	36	41
47	4	9	14	18	23	28	32	37	42
48	4	9	14	19	24	28	33	38	43
49	4	9	14	19	24	29	34	39	44
50	5	10	15	20	25	30	35	40	45
51	5	10	15	20	25	30	35	40	45
52	5	10	15	20	26	31	36	41	46
53	5	10	15	21	26	31	37	42	47
54	5	10	16	21	27	32	37	43	48
55	5	11	16	22	27	33	38	44	49
56	5	11	16	22	28	33	39	44	50
57	5	11	17	22	28	34	39	45	51
58	5	11	17	23	29	34	40	46	52
59	5	11	17	23	29	35	41	47	53
60	6	12	18	24	30	36	42	48	54
61	6	12	18	24	30	36	42	48	54
62	6	12	18	24	31	37	43	49	55

D	1	2	3	4	5	6	7	8	9
63	6	12	18	25	31	37	44	50	56
64	6	12	19	25	32	38	44	51	57
65	6	13	19	26	32	39	45	52	58
66	6	13	19	26	33	39	46	52	59
67	6	13	20	26	33	40	46	53	60
68	6	13	20	27	34	40	47	54	61
69	6	13	20	27	34	41	48	55	62
70	7	14	21	28	35	42	49	56	63
71	7	14	21	28	35	42	49	56	63
72	7	14	21	28	36	43	50	57	64
73	7	14	21	29	36	43	51	58	65
74	7	14	22	29	37	44	51	59	66
75	7	15	22	30	37	45	52	60	67
76	7	15	22	30	38	45	53	60	68
77	7	15	23	30	38	46	53	61	69
78	7	15	23	31	39	46	54	62	70
79	7	15	23	31	39	47	55	63	71
80	8	16	24	32	40	48	56	64	72
81	8	16	24	32	40	48	56	64	72
82	8	16	24	32	41	49	57	65	73
83	8	16	24	33	41	49	58	66	74
84	8	16	25	33	42	50	58	67	75
85	8	17	25	34	42	51	59	68	76
86	8	17	25	34	43	51	60	68	77
87	8	17	26	34	43	52	60	69	78
88	8	17	26	35	44	52	61	70	79
89	8	17	26	35	44	53	62	71	80
90	9	18	27	36	45	54	63	72	81
91	9	18	27	36	45	54	63	72	81
92	9	18	27	36	46	55	64	73	82

D	1	2	3	4	5	6	7	8	9
93	9	18	27	37	46	55	65	74	83
94	9	18	28	37	47	56	65	75	84
95	9	19	28	38	47	57	66	76	85
96	9	19	28	38	48	57	67	76	86
97	9	19	29	38	48	58	67	77	87
98	9	19	29	39	49	58	68	78	88
99	9	19	29	39	49	59	69	79	89
100	10	20	30	40	50	60	70	80	90
101	10	20	30	40	50	60	70	80	90
102	10	20	30	40	51	61	71	81	91
103	10	20	30	41	51	61	72	82	92
104	10	20	31	41	52	62	72	83	93
105	10	21	31	42	52	63	73	84	94
106	10	21	31	42	53	63	74	84	95
107	10	21	32	42	53	64	74	85	96
108	10	21	32	43	54	64	75	86	97
109	10	21	32	43	54	65	76	87	98
110	11	22	33	44	55	66	77	88	99
111	11	22	33	44	55	66	77	88	99
112	11	22	33	44	56	67	78	89	100
113	11	22	33	45	57	67	78	90	101
114	11	22	34	45	57	68	79	91	102
115	11	23	34	46	57	69	80	92	103
116	11	23	34	46	58	69	81	92	104
117	11	23	35	46	58	70	81	73	105
118	11	23	35	47	59	70	82	94	106
119	11	23	35	47	59	71	83	95	107
120	12	24	36	48	60	72	84	96	108
121	12	24	36	48	60	72	84	96	108
122	12	24	36	48	61	73	85	97	109

D	1	2	3	4	5	6	7	8	9
123	12	24	36	48	61	73	86	98	110
124	12	24	37	49	62	74	86	99	111
125	12	25	37	50	62	75	87	100	112
126	12	25	37	50	63	75	88	100	113
127	12	25	38	50	63	76	88	101	114
128	12	25	38	51	64	76	89	102	115
129	12	25	38	51	64	77	90	103	116
130	13	26	39	52	65	78	91	104	117
131	13	26	39	52	65	78	91	104	117
132	13	26	39	52	66	79	92	105	118
133	13	26	39	53	66	79	93	106	119
134	13	26	40	53	67	80	93	107	120
135	13	27	40	54	67	81	94	108	121
136	13	27	40	54	68	81	95	108	122
137	13	27	41	54	68	82	95	109	123
138	13	27	41	55	69	82	96	110	124
139	13	27	41	55	69	83	97	111	125
140	14	28	42	56	70	84	98	112	126
141	14	28	42	56	70	84	99	112	126
142	14	28	42	56	71	85	99	113	127
143	14	28	42	57	71	85	100	114	128
144	14	28	43	57	72	86	100	115	129
145	14	28	43	58	72	87	101	116	130
146	14	29	43	58	73	87	102	116	131
147	14	29	44	58	73	88	102	117	132
148	14	29	44	59	74	88	103	118	133
149	14	29	44	59	74	89	104	119	134
150	15	30	45	60	75	90	105	120	135
151	15	30	45	60	75	90	105	120	135
152	15	30	45	60	76	91	106	121	136

D	1	2	3	4	5	6	7	8	9
153	15	30	45	60	76	91	107	122	137
154	15	30	46	61	77	92	107	123	138
155	15	31	46	62	77	93	108	124	139
156	15	31	46	62	78	93	109	124	140
157	15	31	47	62	78	94	109	125	141
158	15	31	47	63	79	94	110	126	142
159	15	31	47	63	79	95	111	127	143
160	16	32	48	64	80	96	112	128	144
161	16	32	48	64	80	96	112	128	144
162	16	32	48	64	81	97	113	129	145
163	16	32	48	65	82	98	114	130	146
164	16	32	49	66	82	98	114	131	147
165	16	33	49	66	82	99	115	132	148
166	16	33	49	66	83	99	116	132	149
167	16	33	50	66	83	100	116	133	150
168	16	33	50	67	84	100	117	134	151
169	17	33	50	67	84	101	118	135	152
170	17	34	51	68	85	102	119	136	153
171	17	34	51	68	85	102	119	136	153
172	17	34	51	68	86	103	120	137	154
173	17	34	51	69	86	103	121	138	155
174	17	34	52	69	87	104	121	139	156
175	17	34	52	70	87	105	122	140	157
176	17	35	52	70	88	105	123	140	158
177	17	35	53	70	88	106	123	141	159
178	17	35	53	71	89	106	124	142	160
179	17	35	53	71	89	107	125	143	161
180	18	36	54	72	90	108	126	144	162
181	18	36	54	72	90	108	126	144	162
182	18	36	54	72	91	109	127	145	163

D	1	2	3	4	5	6	7	8	9
183	18	36	54	73	91	109	128	146	164
184	18	36	55	73	92	110	128	147	165
185	18	37	55	74	92	111	129	148	166
186	18	37	55	74	93	111	130	148	167
187	18	37	56	74	83	112	130	149	168
188	18	37	56	75	94	112	131	150	169
189	18	37	56	75	94	113	132	151	170
190	19	38	57	76	95	114	133	152	171
191	19	38	57	76	95	114	133	152	171
192	19	38	57	76	96	115	134	153	172
193	19	38	57	77	96	115	135	154	173
194	19	38	58	77	97	116	135	155	174
195	19	39	58	78	97	117	136	156	175
196	19	39	59	78	98	117	136	156	176
197	19	39	59	78	98	118	137	157	177
198	19	39	59	79	99	118	138	158	178
199	19	39	59	79	99	119	139	159	179
200	20	40	60	80	100	120	140	160	180
201	20	40	60	80	100	120	140	160	180
202	20	40	60	80	101	121	141	161	181
203	20	40	60	81	101	121	142	162	182
204	20	40	61	81	102	122	142	163	183
205	20	41	61	82	102	123	143	164	184
206	20	41	61	82	103	123	144	164	185
207	20	41	62	82	103	124	144	165	186
208	20	41	62	83	104	124	145	166	187
209	20	41	62	83	104	125	146	167	188
210	21	42	63	84	105	126	147	168	189
211	21	42	63	84	105	126	147	168	189
212	21	42	63	84	106	127	148	169	190

D	1	2	3	4	5	6	7	8	9
213	21	42	63	85	106	127	149	170	191
214	21	42	64	85	107	128	149	171	192
215	21	43	64	86	107	129	150	172	193
216	21	43	64	86	108	129	151	172	194
217	21	43	65	86	108	130	151	173	195
218	21	43	65	87	109	130	152	174	196
219	21	43	65	87	109	131	153	175	197
220	22	44	66	88	110	132	154	176	198
221	22	44	66	88	110	132	154	176	198
222	22	44	66	88	111	133	155	177	199
223	22	44	66	89	111	133	156	178	200
224	22	44	67	89	112	134	156	179	201
225	22	45	67	90	112	135	157	180	202
226	22	45	67	90	113	135	158	180	203
227	22	45	68	90	113	136	158	181	204
228	22	45	68	91	114	136	159	182	205
229	22	45	68	91	114	137	160	183	206
230	23	46	69	92	115	138	161	184	207
231	23	46	69	92	115	138	161	184	207
232	23	46	69	92	116	139	162	185	208
233	23	46	69	93	116	139	163	186	209
234	23	46	70	93	117	140	163	187	210
235	23	47	70	94	117	141	164	188	211
236	23	47	70	94	118	141	165	188	212
237	23	47	71	94	118	142	165	189	213
238	23	47	71	95	119	142	166	190	214
239	23	47	71	95	119	143	167	191	215
240	24	48	72	96	120	144	168	192	216
241	24	48	72	96	120	144	168	192	216
242	24	48	72	96	121	145	169	193	217

D	1	2	3	4	5	6	7	8	9
243	24	48	72	97	121	145	170	194	218
244	24	48	73	97	122	146	170	195	219
245	24	49	73	98	122	147	171	196	220
246	24	49	73	98	123	147	172	196	221
247	24	49	74	98	123	148	172	197	222
248	24	49	74	99	124	148	173	198	223
249	24	49	74	99	124	149	174	199	224
250	25	50	75	100	125	150	175	200	225
251	25	50	75	100	125	150	175	200	225
252	25	50	75	100	126	151	176	201	226
253	25	50	75	101	126	151	177	202	227
254	25	50	76	101	127	152	177	203	228
255	25	50	76	102	127	153	178	204	229
256	25	51	76	102	128	153	179	204	230
257	25	51	77	102	128	154	179	205	231
258	25	51	77	103	129	154	180	206	232
259	25	51	77	103	129	155	181	207	233
260	26	52	78	104	130	156	182	208	234
261	26	52	78	104	130	156	182	208	234
262	26	52	78	104	131	156	183	209	235
263	26	52	78	105	131	157	184	210	236
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265	26	53	79	106	132	159	185	212	238
266	26	53	79	106	133	159	186	212	239
267	26	53	80	106	133	160	186	213	240
268	26	53	80	107	134	160	187	214	241
269	26	53	80	107	134	161	188	215	242
270	27	54	81	108	135	162	189	216	243
271	27	54	81	108	135	162	189	216	243
272	27	54	81	108	136	163	190	217	244

D	1	2	3	4	5	6	7	8	9
273	27	54	81	109	136	163	191	218	245
274	27	54	82	109	137	164	191	219	246
275	27	55	82	110	137	165	192	220	247
276	27	55	82	110	138	165	193	220	248
277	27	55	83	110	138	166	193	221	249
278	27	55	83	111	139	166	194	222	250
279	27	55	83	111	139	167	195	223	251
280	28	56	84	112	140	168	196	224	252
281	28	56	84	112	140	168	196	224	252
282	28	56	84	112	141	169	197	225	253
283	28	56	84	113	141	169	198	226	254
284	28	56	85	113	142	170	198	227	255
285	28	57	85	114	142	171	199	228	256
286	28	57	85	114	143	171	200	228	257
287	28	57	86	114	143	172	200	229	258
288	28	57	86	115	144	172	201	230	259
289	28	57	86	115	144	173	202	231	260
290	29	58	87	116	145	174	203	232	261
291	29	58	87	116	145	174	203	232	261
292	29	58	87	116	146	175	204	233	262
293	29	58	87	117	146	175	205	234	263
294	29	58	88	117	147	176	205	235	264
295	29	59	88	118	147	177	206	236	265
296	29	59	88	118	148	177	207	236	266
297	29	59	88	118	148	178	207	237	267
298	29	59	89	119	149	178	208	238	268
299	29	59	89	119	149	179	209	239	269
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301	30	60	90	120	150	180	210	240	270
302	30	60	90	120	151	181	211	241	271

D	1	2	3	4	5	6	7	8	9
303	30	60	90	121	151	181	212	242	272
304	30	60	91	121	152	182	212	243	273
305	30	61	91	122	152	183	213	244	274
306	30	61	91	122	153	183	214	244	275
307	30	61	92	122	153	184	214	245	276
308	30	61	92	123	154	184	215	246	277
309	30	61	92	123	154	185	216	247	278
310	31	62	93	124	155	186	217	248	279
311	31	62	93	124	155	186	217	248	279
312	31	62	93	124	156	187	218	249	280
313	31	62	93	125	156	187	219	250	281
314	31	62	94	125	157	188	219	251	282
315	31	63	94	126	157	189	220	252	283
316	31	63	94	126	158	189	221	252	284
317	31	63	95	126	158	190	221	253	285
318	31	63	95	127	159	190	222	254	286
319	31	63	95	127	159	191	223	255	287
320	32	64	96	128	160	192	224	256	288
321	32	64	96	128	160	192	224	256	288
322	32	64	96	128	161	193	225	257	289
323	32	64	96	129	161	193	226	258	290
324	32	64	97	129	162	194	226	259	291
325	32	65	97	130	162	195	227	260	292
326	32	65	97	130	163	195	228	260	293
327	32	65	98	130	163	196	228	261	294
328	32	65	98	131	163	196	229	262	295
329	32	65	98	131	164	197	230	263	296
330	33	66	99	132	165	198	231	264	297
331	33	66	99	132	165	198	231	264	297
332	33	66	99	132	166	199	232	265	298

D	1	2	3	4	5	6	7	8	9
333	33	66	99	133	166	199	233	266	299
334	33	66	100	133	167	200	233	267	300
335	33	67	100	134	167	201	234	268	301
336	33	67	100	134	168	201	235	268	302
337	33	67	101	134	168	202	235	269	303
338	33	67	101	135	169	202	236	270	304
339	33	67	101	135	169	203	237	271	305
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341	34	68	102	136	170	204	238	272	306
342	34	68	102	136	171	205	239	273	307
343	34	68	102	137	171	205	240	274	308
344	34	68	103	137	172	206	240	275	309
345	34	69	103	138	172	207	241	276	310
346	34	69	103	138	173	207	242	276	311
347	34	69	104	138	173	208	242	277	312
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350	35	70	105	140	175	210	245	280	315
351	35	70	105	140	175	210	245	280	315
352	35	70	105	140	176	211	246	281	316
353	35	70	105	141	176	211	247	282	317
354	35	70	106	141	177	212	247	283	318
355	35	71	106	142	177	213	248	284	319
356	35	71	106	142	178	213	249	284	320
357	35	71	107	142	178	214	249	285	321
358	35	71	107	143	179	214	250	286	322
359	35	71	107	143	179	215	251	287	323
360	36	72	108	144	180	216	252	288	324
361	36	72	108	144	180	216	252	288	324
362	36	72	108	144	181	217	253	289	325

D	1	2	3	4	5	6	7	8	9
363	36	72	108	145	181	217	254	290	326
364	36	72	109	145	182	218	254	291	327
365	36	73	109	146	182	219	255	292	328
366	36	73	109	146	182	219	256	292	329
367	36	73	110	146	183	220	256	293	330
368	36	73	110	147	184	220	257	294	331
369	36	73	110	147	184	221	258	295	332
370	37	74	111	148	185	222	259	296	333
371	37	74	111	148	185	222	259	296	333
372	37	74	111	148	186	223	260	297	334
373	37	74	111	149	186	223	261	298	335
374	37	74	112	149	187	224	261	299	336
375	37	75	112	150	187	225	262	300	337
376	37	75	112	150	188	225	263	300	338
377	37	75	113	150	188	226	263	301	339
378	37	75	113	151	189	226	264	302	340
379	37	75	113	151	189	227	265	303	341
380	38	76	114	152	190	228	266	304	342
381	38	76	114	152	190	228	266	304	342
382	38	76	114	152	191	229	267	305	343
383	38	76	114	153	191	229	268	306	344
384	38	76	115	153	192	230	268	307	345
385	38	77	115	154	192	231	269	308	346
386	38	77	115	154	193	231	270	308	347
387	38	77	116	154	193	232	270	309	348
388	38	77	116	155	194	232	271	310	349
389	38	77	116	155	194	233	272	311	350
390	39	78	117	156	195	233	273	312	351
391	39	78	117	156	195	233	273	312	351
392	39	78	117	156	196	234	274	313	352

D	1	2	3	4	5	6	7	8	9
393	39	78	117	157	196	235	275	314	353
394	39	78	118	157	197	236	275	315	354
395	39	79	118	158	197	237	276	316	355
396	39	79	118	158	198	237	277	316	356
397	39	79	119	158	198	238	277	317	357
398	39	79	119	159	199	238	278	318	358
399	39	79	119	159	199	239	279	319	359
400	40	80	120	160	200	240	280	320	360
401	40	80	120	160	200	240	280	320	360
402	40	80	120	160	201	241	281	321	361
403	40	80	120	161	201	241	282	322	362
404	40	80	121	161	202	242	282	323	363
405	40	81	121	162	202	243	283	324	364
406	40	81	121	162	203	243	284	324	365
407	40	81	122	162	203	244	284	325	366
408	40	81	122	163	204	244	285	326	367
409	40	81	122	163	204	245	286	327	368
410	41	82	123	164	205	246	287	328	369
411	41	82	123	164	205	246	287	328	369
412	41	82	123	164	206	247	288	329	370
413	41	82	123	165	206	247	289	330	371
414	41	82	124	165	207	248	289	331	372
415	41	83	124	166	207	249	290	332	373
416	41	83	124	166	208	249	291	332	374
417	41	83	125	166	208	250	291	333	375
418	41	83	125	167	209	250	292	334	376
419	41	83	125	167	209	251	293	335	377
420	42	84	126	168	210	252	294	336	378
421	42	84	126	168	210	252	294	336	378
422	42	84	126	168	211	253	295	337	379

D	1	2	3	4	5	6	7	8	9
423	42	84	126	169	211	253	296	338	380
424	42	84	127	169	212	254	296	339	381
425	42	85	127	170	212	255	297	340	382
426	42	85	127	170	213	255	298	340	383
427	42	85	128	170	213	256	298	341	384
428	42	85	128	171	214	256	299	342	385
429	42	85	128	171	214	257	300	343	386
430	43	86	129	172	215	258	301	344	387
431	43	86	129	172	215	258	301	344	387
432	43	86	129	172	216	259	302	345	388
433	43	86	129	173	216	259	303	346	389
434	43	86	130	173	217	260	304	347	390
435	43	87	130	174	217	261	304	348	391

A Ta-

A TABLE OF ARTIFICIAL SINES AND TANGENTS

To every

DEGREE and MINUTE OF THE

QUADRANT.

LONDON,

Printed by *J. Heptinstall* for *W. Freeman*, at the *Artichoke* next St. *Dunstan's* Church in *Fleetstreet*. MDCLXXXVII.

M	Sine	Co-sine	Tangent	Co-tang.	
0	0.000000	10.000000	0.000000	*Infinita.*	60
1	6.463726	9.999999	6.463726	13.536274	59
2	6.764756	9.999999	6.764756	13.235244	58
3	6.940847	9.999999	6.940847	13.059153	57
4	7.065786	9.999999	7.065786	12.934214	56
5	7.162696	9.999999	7.162696	12.837304	55
6	7.241877	9.999999	7.241878	12.758122	54
7	7.308824	9.999999	7.308825	12.691175	53
8	7.366816	9.999999	7.366817	12.633183	52
9	7.417968	9.999999	7.417970	12.582030	51
10	7.463726	9.999998	7.463727	12.536273	50
11	7.505118	9.999998	7.505120	12.494880	49
12	7.542906	9.999997	7.542909	12.457091	48
13	7.577668	9.999997	7.577272	12.422328	47
14	7.609853	9.999996	7.609857	12.390143	46
15	7.639816	9.999996	7.639826	12.360180	45
16	7.667844	9.999995	7.667849	12.332151	44
17	7.694173	9.999995	7.694179	12.305821	43
18	7.718977	9.999994	7.719003	12.281997	42
19	7.742477	9.999993	7.742484	12.257516	41
20	7.764754	9.999993	7.764761	12.235239	40
21	7.785943	9.999992	7.785951	12.214049	39
22	7.806146	9.999991	7.806145	12.193845	38
23	7.825451	9.999990	7.825460	12.174540	37
24	7.843034	9.999989	7.843944	12.156056	36
25	7.861662	9.999989	7.861674	12.138326	35
26	7.878695	9.999988	7.878708	12.121292	34
27	7.895085	9.999987	7.895099	12.104901	33
28	7.910879	9.999986	7.910894	12.089106	32
29	7.926119	9.999985	7.926134	12.073866	31
30	7.940842	9.999983	7.940858	12.059142	30
	Co-sine	Sine	*Co-tang.*	Tangent	M

M	Sine	Co-sine	Tangent	Co-tang.	
30	7.940842	9.999983	7.940858	12.059142	30
31	7.955082	9.999982	7.955100	12.044900	29
32	7.968870	9.999981	7.968889	12.031111	28
33	7.982233	9.999980	7.982253	12.017747	27
34	7.995198	9.999978	7.995215	12.004781	26
35	8.007787	9.999978	8.007810	11.992191	25
36	8.020021	9.999976	8.020044	11.979956	24
37	8.031919	9.999975	8.031945	11.968055	23
38	8.043601	9.999973	8.043527	11.956473	22
39	8.054781	9.999972	8.054809	11.945181	21
40	8.065776	9.999971	8.065806	11.934194	20
41	8.076500	9.999969	8.076531	11.923469	19
42	8.086965	9.999968	8.086997	11.913003	18
43	8.097183	9.999966	8.097217	11.902783	17
44	8.107167	9.999964	8.107203	11.892797	16
45	8.116926	9.999963	8.116963	11.883037	15
46	8.126471	9.999961	8.126510	11.873490	14
47	8.135810	9.999959	8.135851	11.864149	13
48	8.144953	9.999958	8.144996	11.855004	12
49	8.153907	9.999956	8.153952	11.846048	11
50	8.162681	9.999954	8.162737	11.837273	10
51	8.171280	9.999952	8.171328	11.828672	9
52	8.179713	9.999950	8.179763	11.820237	8
53	8.187985	9.999948	8.188036	11.811964	7
54	8.196102	9.999946	8.196156	11.803844	6
55	8.204070	9.999944	8.204126	11.795674	5
56	8.211895	9.999942	8.211953	11.788047	4
57	8.219581	9.999940	8.219641	11.780359	3
58	8.227134	9.999938	8.227195	11.772805	2
59	8.234557	9.999936	8.2346[illegible]	11.765379	1
60	8.241855	9.999934	8.241921	11.758079	0
	Co-sine	Sine	Co-tang.	Tangent	M

Degree 89.

Degree 1.

M	Sine	Co-sine	Tangent	Co-tang.	
0	8.241855	9.999934	8.241921	11.758079	60
1	8.249033	9.999932	8.249102	11.750898	59
2	8.256094	9.999929	8.256165	11.743835	58
3	8.263042	9.999927	8.263115	11.736885	57
4	8.269881	9.999925	8.269956	11.730044	56
5	8.276614	9.999922	8.276691	11.723309	55
6	8.283243	9.999920	8.283323	11.716677	54
7	8.289773	9.999918	8.289856	11.716144	53
8	8.296207	9.999915	8.296292	11.703708	52
9	8.302546	9.999913	8.302634	11.697366	51
10	8.308794	9.999910	8.308884	11.691116	50
11	8.314954	9.999907	8.315046	11.684954	49
12	8.321027	9.999905	8.321122	11.678878	48
13	8.327016	9.999902	8.327114	11.672886	47
14	8.332924	9.999899	8.333025	11.666975	46
15	8.338753	9.999897	8.338856	11.661144	45
16	8.344504	9.999894	8.344610	11.655390	44
17	8.350180	9.999891	8.350289	11.649711	43
18	8.355783	9.999888	8.355895	11.644105	42
19	8.361315	9.999885	8.361430	11.638570	41
20	8.366777	9.999882	8.366895	11.633105	40
21	8.372171	9.999879	8.372292	11.627708	39
22	8.377499	9.999876	8.377622	11.622378	38
23	8.387762	9.999873	8.382889	11.617111	37
24	8.387962	9.999870	8.388092	11.611908	36
25	8.393101	9.999867	8.393234	11.606766	35
26	8.398179	9.999864	8.398315	11.601685	34
27	8.403199	9.999861	8.403338	11.596662	33
28	8.408161	9.999858	8.408304	11.591696	32
29	8.413068	9.999854	8.413213	11.586787	31
30	8.417919	9.999851	8.418068	11.581932	30
	Co-sine	Sine	Co-tang.	Tangent	M

Degree 88.

M	Sine	Co-sine	Tangent	Co-tang.	
30	8.417919	9.999851	8.418068	11.581932	30
31	8.422717	9.999848	8.422869	11.577131	29
32	8.427462	9.999844	8.427618	11.572382	28
33	8.432156	9.999841	8.432315	11.567685	27
34	8.436800	9.999838	8.436962	11.563038	26
35	8.441394	9.999834	8.441560	11.558440	25
36	8.445941	9.999831	8.446110	11.553990	24
37	8.450440	9.999827	8.450613	11.549387	23
38	8.454893	9.999824	8.455070	11.544930	22
39	8.459301	9.999820	8.459481	11.540519	21
40	8.463665	9.999816	8.463849	11.536151	20
41	8.467985	9.999812	8.468172	11.531828	19
42	8.472263	9.999809	8.472454	11.527546	18
43	8.476498	9.999805	8.476693	11.523307	17
44	8.480693	9.999801	8.480892	11.519108	16
45	8.484848	9.999797	8.485050	11.514950	15
46	8.488963	9.999794	8.486170	11.510830	14
47	8.493040	9.999790	8.483250	11.506750	13
48	8.497078	9.999786	8.497293	11.502707	12
49	8.501080	9.999782	8.501298	11.498702	11
50	8.505045	9.999778	8.505267	11.494733	10
51	8.508974	9.999774	8.509200	11.490800	9
52	8.512867	9.999769	8.513098	11.486902	8
53	8.516726	9.999765	8.516961	11.483039	7
54	8.520551	9.999761	8.520790	11.479210	6
55	8.524343	9.999756	8.524586	11.475414	5
56	8.528102	9.999753	8.528349	11.471651	4
57	8.531828	9.999748	8.532080	11.467620	3
58	8.535523	9.999744	8.535779	11.464221	2
59	8.539186	9.999740	8.539447	11.460553	1
60	8.542819	9.999735	8.543084	11.456916	0
	Co-sine	Sine	Co-tang.	Tangent	M

Degree 88.

M	Sine	Co-sine	Tangent	Co-tang.	
0	8.542819	9.999735	8.543084	11.456916	60
1	8.546422	9.999731	8.546691	11.453309	59
2	8.549995	9.999726	8.550268	11.449732	58
3	8.553558	9.999722	8.553817	11.446183	57
4	8.557054	9.999717	8.557336	11.442664	56
5	8.560540	9.999713	8.560827	11.439172	55
6	8.563999	9.999708	8.564291	11.435709	54
7	8.567431	9.999703	8.567727	11.432272	53
8	8.570836	9.999699	8.571137	11.428863	52
9	8.574214	9.999694	8.574520	11.425480	51
10	8.577566	9.999689	8.577877	11.422123	50
11	8.580892	9.999685	8.581208	11.418792	49
12	8.584193	9.999680	8.584514	11.415486	48
13	8.587469	9.999675	8.587795	11.412205	47
14	8.590721	9.999670	8.591051	11.408949	46
15	8.593948	9.999665	8.594283	11.405717	45
16	8.597152	9.999660	8.597492	11.402508	44
17	8.600332	9.999655	8.600677	11.399323	43
18	8.603488	9.999650	8.603838	11.396161	42
19	8.606622	9.999645	8.606978	11.393022	41
20	8.609734	9.999640	8.610094	11.389906	40
21	8.612823	9.999635	8.613189	11.386811	39
22	8.615891	9.999629	8.616262	11.383738	38
23	8.618937	9.999624	8.619313	11.380687	37
24	8.621967	9.999619	8.622343	11.377657	36
25	8.624965	9.999614	8.625352	11.374648	35
26	8.627948	9.999608	8.628340	11.371660	34
27	8.630911	9.999603	8.631308	11.368692	33
28	8.633854	9.999597	8.634456	11.365744	32
29	8.636776	9.999592	8.637184	11.362816	31
30	8.639679	9.999586	8.640093	11.359907	30
	Co-sine	Sine	Co-tang.	Tangent	M

M	Sine	Co-sine	Tangent	Co-tang.	
30	8.639679	9.999586	8.640093	11.359907	30
31	8.642563	9.999581	8.642982	11.357017	29
32	8.645428	9.999575	8.645853	11.354147	28
33	8.648274	9.999570	8.648704	11.351296	27
34	8.651102	9.999564	8.651538	11.348463	26
35	8.653911	9.999558	8.654352	11.345648	25
36	8.656702	9.999553	8.657149	11.342851	24
37	8.659475	9.999547	8.659928	11.340072	23
38	8.662230	9.999541	8.662689	11.337311	22
39	8.664968	9.999535	8.665433	11.334567	21
40	8.667689	9.999529	8.668160	11.331840	20
41	8.670393	9.999523	8.670869	11.329130	19
42	8.673080	9.999518	8.673563	11.326437	18
43	8.675751	9.999512	8.676239	11.323761	17
44	8.678405	9.999506	8.678899	11.321100	16
45	8.681043	9.999499	8.681544	11.318456	15
46	8.683665	9.999493	8.684172	11.315828	14
47	8.686272	9.999487	8.686784	11.313216	13
48	8.688892	9.999481	8.689381	11.310619	12
49	8.691438	9.999475	8.691963	11.308037	11
50	8.693998	9.999469	8.694529	11.305471	10
51	8.696543	9.999462	8.697081	11.302919	9
52	8.699073	9.999456	8.699617	11.300383	8
53	8.701589	9.999450	8.702139	11.297861	7
54	8.704090	9.999443	8.704646	11.295354	6
55	8.706576	9.999437	8.707130	11.292860	5
56	8.709049	9.999431	8.709618	11.290381	4
57	8.711507	9.999424	8.712083	11.287917	3
58	8.713952	9.999418	8.714534	11.285466	2
59	8.716383	9.999411	8.716972	11.283028	1
60	8.718800	9.999404	8.719396	11.280604	0
	Co-sine	Sine	Co-tang.	Tangent	M

Degree 87.

M	Sine	Co-sine	Tangent	Co-tang.	
0	8.718800	9.999404	8.719396	11.280604	60
1	8.721204	9.999398	8.721806	11.278194	59
2	8.723595	9.999391	8.724254	11.275796	58
3	8.725972	9.999384	8.726588	11.273412	57
4	8.728336	9.999378	8.728959	11.271041	56
5	8.730688	9.999371	8.731317	11.268683	55
6	8.733027	9.999364	8.733663	11.266337	54
7	8.735354	9.999357	8.735996	11.264004	53
8	8.737667	9.999350	8.738317	11.261683	52
9	8.739969	9.999343	8.740626	11.259374	51
10	8.742259	9.999336	8.742922	11.257078	50
11	8.744536	9.999329	8.745007	11.254793	49
12	8.746801	9.999322	8.747479	11.252521	48
13	8.745955	9.999315	8.749740	11.250240	47
14	8.751297	9.999308	8.751989	11.248011	46
15	8.753528	9.999301	8.754227	11.245773	45
16	8.755747	9.999294	8.756453	11.243542	44
17	8.757955	9.999286	8.758668	11.241332	43
18	8.760151	9.999279	8.760872	11.239128	42
19	8.762337	9.999272	8.763065	11.236935	41
20	8.764511	9.999265	8.765246	11.234754	40
21	8.766675	9.999257	8.767417	11.232583	39
22	8.768828	9.999250	8.769578	11.230422	38
23	8.770970	9.999242	8.771727	11.228273	37
24	8.773101	9.999235	8.773866	11.229134	36
25	8.775223	9.999227	8.775995	11.224005	35
26	8.777333	9.999220	8.778114	11.221886	34
27	8.779434	9.999212	8.783222	11.219778	33
28	8.781524	9.999204	8.782320	11.217680	32
29	8.783605	9.999197	8.784404	11.215592	31
30	8.785675	9.999189	8.786486	11.213514	30
	Co-sine	Sine	Co-tang.	Tangent	M

M	Sine	Co-sine	Tangent	Co-tang.	
30	8.785675	9.999189	8.786486	11.213514	30
31	8.787736	9.999181	8.788554	11.211446	29
32	8.789787	9.999174	8.790613	11.209387	28
33	8.791828	9.999166	8.792662	11.207338	27
34	8.793859	9.999158	8.794701	11.205299	26
35	8.795881	9.999150	8.796731	11.203269	25
36	8.797894	9.999142	8.798752	11 201248	24
37	8.799897	9.999134	8.800763	11.199237	23
38	8.801891	9.999126	8.802765	11.197235	22
39	8.803876	9.999118	8.807458	11.195242	21
40	8.805852	9.999110	8.806742	11.193258	20
41	8.807819	9.999102	8.808717	11.191283	19
42	8.809777	9.999094	8.812683	11.189317	18
43	8.811726	9.999086	8.812641	11.187359	17
44	8.813667	9.999077	8.814589	11.185411	16
45	8.815598	9.999069	8.816529	11.183471	15
46	8.817522	9.999061	8.818461	11.181539	14
47	8.819436	9.999052	8.820384	11.179616	13
48	8.821342	9.999044	8.822298	11.177702	12
49	8.823240	9.999036	8.824205	11.175795	11
50	8.825130	9.999027	8.826103	11.173897	10
51	8.827011	9.999019	8.827992	11.172008	9
52	8.828884	9.999010	8.829874	11.170126	8
53	8.830749	9.999002	8.831748	11.168252	7
54	8.832106	9.998993	8.833613	11.166387	6
55	8.834456	9.998984	8.835471	11.164529	5
56	8.836297	9.998976	8.837321	11.162679	4
57	8.838130	9.998967	8.839163	11.160837	3
58	8.839956	9.998958	8.840998	11.159002	2
59	8.841774	9.998940	8.842825	11.157175	1
60	8.843585	9.998941	8.844644	11.155356	0
	Co-sine	Sine	Co-tang.	Tangent.	M

Degree 86.

M	Sine	*Co-sine*	Tangent	*Co-tang.*	
0	8.843584	9.998941	8.844644	11.155356	60
1	8.845387	9.998931	8.846455	11.153545	59
2	8.847183	9.998923	8.848240	11.151740	58
3	8.848971	9.998914	8.850057	11.149943	57
4	8.850751	9.998905	8.851846	11.148154	56
5	8.852525	9.998896	8.853628	11.146372	55
6	8.854291	9.998887	8.855403	11.144597	54
7	8.856049	9.998878	8.857171	11.142829	53
8	8.857801	9.998869	8.858932	11.141068	52
9	8.859546	9.998860	8.860686	11.139314	51
10	8.861283	9.998851	8.862433	11.137567	50
11	8.863014	9.998841	8.864173	11.135827	49
12	8.864738	9.998832	8.865906	11.134094	48
13	8.866454	9.998823	8.867632	11.132368	47
14	8.868165	9.998813	8.869351	11.130649	46
15	8.869868	9.998804	8.871064	11.128936	45
16	8.871565	9.998795	8.872750	11.127230	44
17	8.873255	9.998785	8.874469	11.125531	43
18	8.874938	9.998776	8.876162	11.123838	42
19	8.876615	9.998766	8.897849	11.122151	41
20	8.878285	9.998757	8.879529	11.120471	40
21	8.879949	9.998747	8.881202	11.118798	39
22	8.881607	9.998738	8.882869	11.117131	38
23	8.883258	9.998728	8.884530	11.115470	37
24	8.884903	9.998718	8.886185	11.113815	36
25	8.886542	9.998708	8.887833	11.112167	35
26	8.888174	9.998699	8.889476	11.110524	34
27	8.889801	9.998689	8.891112	11.108888	33
28	8.891421	9.998679	8.892742	11.107258	32
29	8.893035	9.998669	8.894366	11.105634	31
30	8.894643	9.998659	8.845984	11.104016	30
	Co-sine.	Sine	*Co-tang.*	Tangent.	M

M	Sine	Co-fine	Tangent	Co-tang.	
30	8.894643	9.998659	8.895984	11.104016	30
31	8.896246	9.998649	8.897596	11.102404	29
32	8.897842	9.998639	8.899203	11.100797	28
33	8.899432	9.998629	8.900803	11.099197	27
34	8.901017	9.998619	8.902398	11.097602	26
35	8.902596	9.998609	8.903987	11.096013	25
36	8.904169	9.998599	8.905570	11.094430	24
37	8.905736	9.998589	8.907147	11.092853	23
38	8.907297	9.998577	8.908719	11.091281	22
39	8.908853	9.998568	8.910285	11.089715	21
40	8.910404	9.998558	8.911846	11.088154	20
41	8.911949	9.998548	8.913401	11.086599	19
42	8.913488	9.998537	8.914951	11.085049	18
43	8.915022	9.998527	8.916495	11.083505	17
44	8.916550	9.998516	8.918034	11.081966	16
45	8.918073	9.998506	8.919568	11.080432	15
46	8.919591	9.998495	8.921096	11.078904	14
47	8.921103	9.998485	8.922619	11.077381	13
48	8.922610	9.998474	8.924136	11.075864	12
49	8.924112	9.998464	8.925649	11.074351	11
50	8.925609	9.998453	8.927156	11.072844	10
51	8.927100	9.998442	8.928658	11.071342	9
52	8.928587	9.998431	8.930155	11.069845	8
53	8.930068	9.998421	8.931647	11.068353	7
54	8.931544	9.998410	8.933134	11.066866	6
55	8.933015	9.998399	8.934616	11.065384	5
56	8.934481	9.998388	8.936093	11.063907	4
57	8.935942	9.998377	8.937565	11.062435	3
58	8.937398	9.998366	8.939032	11.060968	2
59	8.938850	9.998355	8.940494	11.059506	1
60	8.940296	9.998344	8.941952	11.058048	0
	Co-fine	Sine	Co-tang.	Tangent.	M

M	Sine	Co-*sine*	Tangent	*Co-tang.*	
0	8.940296	9.998344	8.941952	11.058048	60
1	8.941738	9.998333	8.943404	11.056596	59
2	8.943174	9.998322	8.944852	11.055148	58
3	8.944606	9.998311	8.946295	11.053705	57
4	8.946034	9.998300	8.947734	11.052266	56
5	8.957456	9.998289	8.949168	11.050832	55
6	8.958814	9.998277	8.950597	11.049403	54
7	8.950287	9.998266	8.952021	11.047979	53
8	8.951696	9.998255	8.953441	11.046559	52
9	8.953099	9.998243	8.954856	11.045144	51
10	8.954499	9.998232	8.956267	11.043733	50
11	8.955894	9.998220	8.957674	11.042326	49
12	8.957284	9.998209	8.959075	11.040925	48
13	8.958670	9.998197	8.960473	11.039527	47
14	8.960052	9.998186	8.961866	11.038134	46
15	8.961429	9.998174	8.963254	11.036746	45
16	8.962801	9.998163	8.964639	11.035361	44
17	8.964170	9.998151	8.966019	11.033981	43
18	8.965534	9.998139	8.967394	11.032606	42
19	8.966893	9.998128	8.968766	11.031234	41
20	8.968249	9.998106	8.970133	11.029867	40
21	8.969600	9.998104	8.971495	11.028505	39
22	8.970947	9.998092	8.972855	11.027145	38
23	8.972289	9.998080	8.974209	11.025791	37
24	8.973626	9.998068	8.975560	11.024440	36
25	8.974962	9.998056	8.976906	11.023094	35
26	8.976293	9.998044	8.978248	11.021752	34
27	8.977619	9.998032	8.979586	11.020414	33
28	8.978941	9.998020	8.980921	11.019079	32
29	8.980259	9.998008	8.982251	11.017749	31
30	8.981573	9.997996	8.983577	11.016423	30
	Co-sine.	Sine	*Co-tang.*	Tangent.	M

Degree 84.

M	Sine	Co-sine	Tangent	Co-tang.	
30	8.981573	9.997996	8.983577	11.016423	30
31	8.982883	9.997984	8.984899	11.015101	29
32	8.984189	9.997971	8.986217	11.013783	28
33	8.985491	9.997959	8.987532	11.012468	27
34	8.986789	9.997947	8.988842	11.011158	26
35	8.988083	9.997935	8.990149	11.009851	25
36	8.989374	9.997922	8.991451	11.008549	24
37	8.990660	9.997910	8.992750	11.007250	23
38	8.991943	9.997897	8.994045	11.005955	22
39	8.993228	9.997885	8.995337	11.004663	21
40	8.994497	9.997873	8.996624	11.003376	20
41	8.995768	9.997860	8.997908	11.002092	19
42	8.997036	9.997847	8.999188	11.000812	18
43	8.998299	9.997835	9.000465	10.999535	17
44	8.999560	9.997822	9.001738	10.998262	16
45	9.000816	9.997809	9.003007	10.996993	15
46	9.002069	9.997797	9.004272	10.995728	14
47	9.003318	9.997784	9.005534	10.994466	13
48	9.004563	9.997771	9.006792	10.993208	12
49	9.005805	9.997758	9.008047	10.991953	11
50	9.007044	9.997730	9.009298	10.990708	10
51	9.008278	9.997732	9.010546	10.989454	9
52	9.009510	9.997719	9.011790	10.988210	8
53	9.010737	9.997706	9.013031	10.986969	7
54	9.011962	9.997693	9.014268	10.985732	6
55	9.013182	9.997680	9.015502	10.984498	5
56	9.014399	9.997667	9.016732	10.983268	4
57	9.015613	9.997654	9.017959	10.982041	3
58	9.016824	9.997641	9.019183	10.980817	2
59	9.018031	9.997628	9.020403	10.979597	1
60	9.019235	9.997612	9.021620	10.978380	0
	Co-sine	Sine	Co-tang.	Tangent	M

Degree 84.

M	Sine	*Co-sine*	Tangent	*Co-tang.*	M
0	9.019235	9.997614	9.021620	10.978380	60
1	9.020435	9.997601	9.022834	10.977166	59
2	9.021632	9.997588	9.024044	10.975956	58
3	9.022825	9.997574	9.025251	10.974749	57
4	9.024016	9.997561	9.026455	10.973545	56
5	9.025203	9.997548	9.027655	10.972345	55
6	9.026386	9.997534	9.028852	10.971148	54
7	9.027567	9.997520	9.030046	10.969954	53
8	9.028744	9.997507	9.031237	10.968763	52
9	9.029918	9.997493	9.032425	10.967575	51
10	9.031089	9.997480	9.033609	10.966391	50
11	9.032257	9.997466	9.034791	10.965209	49
12	9.033421	9.997452	9.035969	10.964031	48
13	9.034582	9.997439	9.036144	10.962856	47
14	9.035741	9.997425	9.038316	10.961684	46
15	9.036896	9.997411	9.039485	10.960515	45
16	9.038048	9.997397	9.040651	10.959349	44
17	9.039197	9.997383	9.041813	10.958187	43
18	9.040342	9.997369	9.042973	10.957027	42
19	9.041485	9.997355	9.044130	10.955870	41
20	9.042625	9.997341	9.045284	10.954716	40
21	9.043762	9.997327	9.046434	10.953566	39
22	9.044895	9.997313	9.047582	10.952418	38
23	9.046026	9.997299	9.048727	10.951273	37
24	9.047154	9.997285	9.049869	10.950131	36
25	9.049279	9.997271	9.051008	10.948992	35
26	9.049400	9.997256	9.052144	10.947856	34
27	9.050519	9.997242	9.043277	10.946723	33
28	9.051635	9.997228	9.054408	10.945592	32
29	9.052749	9.997214	9.055535	10.944465	31
30	9.053859	9.997199	9.056640	10.943340	30
	Co-sine	Sine	*Co-tang.*	Tangent	M

M	Sine	Co-sine	Tangent	Co-tang.	M
30	9.053859	9.997199	9.056640	10.943340	30
31	9.054966	9.997185	9.057781	10.942219	29
32	9.056071	9.997170	9.058900	10.941100	28
33	9.057172	9.997156	9.060016	10.939984	27
34	9.058271	9.997141	9.061130	10.938870	26
35	9.059367	9.997127	9.062240	10.937760	25
36	9.060460	9.997112	9.063348	10.936652	24
37	9.061551	9.997098	9.064453	10.935547	23
38	9.062638	9.997083	9.065556	10.934444	22
39	9.063723	9.997068	9.066655	10.933345	21
40	9.064806	9.997053	9.067752	10.932248	20
41	9.065885	9.997039	9.068847	10.931153	19
42	9.066962	9.997024	9.069938	10.930062	18
43	9.063036	9.997009	9.071027	10.928973	17
44	9.069107	9.996994	9.072113	10.927887	16
45	9.070176	9.996979	9.073197	10.926803	15
46	9.071242	9.996964	9.074278	10.925722	14
47	9.072306	9.996949	9.075356	10.924644	13
48	9.073366	9.996934	9.076432	10.923568	12
49	9.074424	9.996919	9.077505	10.922495	11
50	9.075480	9.996904	9.078576	10.921424	10
51	9.076533	9.996889	9.079644	10.920356	9
52	9.077583	9.996874	9.080710	10.919290	8
53	9.078631	9.996858	9.081773	10.918227	7
54	9.079676	9.996843	9.082833	10.917167	6
55	9.080719	9.996828	9.083891	10.916109	5
56	9.081759	9.996812	9.084947	10.915053	4
57	9.082797	9.996797	9.085999	10.914100	3
58	9.083832	9.996782	9.087050	10.912950	2
59	9.084864	9.996766	9.088098	10.911902	1
60	9.085894	9.996751	9.089144	10.910856	0
	Co-sine	Sine	Co-tang.	Tangent	M

M	Sine	*Co-sine*	Tangent	*Co-tang.*	
0	9.085894	9.996751	9.089144	10.910856	60
1	9.086922	9.996735	9.090187	10.909813	59
2	9.087947	9.996720	9.091228	10.908772	58
3	9.088970	9.996704	9.092266	10.907734	57
4	9.089990	9.996688	9.093302	10.906698	56
5	9.091088	9.996673	9.094336	10.905664	55
6	9.092024	9.996657	9.095367	10.904633	54
7	9.093037	9.996641	9.096395	10.903604	53
8	9.094047	9.996625	9.097422	10.902578	52
9	9.095056	9.996610	9.098446	10.901554	51
10	9.096062	9.996594	9.099468	10.900532	50
11	9.097065	9.996578	9.100487	10.899513	49
12	9.098066	9.996562	9.101504	10.898496	48
13	9.099065	9.996546	9.102519	10.897481	47
14	9.100062	9.996530	9.103532	10.896468	46
15	9.101056	9.996514	9.104542	10.895458	45
16	9.102048	9.996498	9.105550	10.894450	44
17	9.103037	9.996482	9.106556	10.893444	43
18	9.104025	9.996465	9.107559	10.892441	42
19	9.105010	9.996449	9.108560	10.891440	41
20	9.105992	9.996433	9.109559	10.890441	40
21	9.106973	9.996417	9.110556	10.889444	39
22	9.107951	9.996400	9.111551	10.888449	38
23	9.108927	9.996384	9.112543	10.887457	37
24	9.109901	9.996368	9.113533	10.886467	36
25	9.110873	9.996351	9.114521	10.885478	35
26	9.111842	9.996335	9.115507	10.884493	34
27	9.112809	9.996318	9.116491	10.883509	33
28	9.113774	9.996302	9.117472	10.882528	32
29	9.114737	9.996285	9.118452	10.881548	31
30	9.115698	9.996269	9.119429	10.880571	30
	Co-sine	Sine	*Co-tang.*	Tangent	M

M	Sine	Co-sine	Tangent	Co-tang.	
30	9.115698	9.996269	9.119429	10.880571	30
31	9.116656	9.996252	9.120404	10.879596	29
32	9.117612	9.996235	9.121377	10.878623	28
33	9.118567	9.996218	9.122348	10.877652	27
34	9.119519	9.996202	9.123317	10.876683	26
35	9.120469	9.996185	9.124284	10.875716	25
36	9.121417	9.996168	9.125248	10.874751	24
37	9.122362	9.996151	9.126211	10.873789	23
38	9.123306	9.996134	9.127172	10.872828	22
39	9.124248	9.996117	9.128130	10.871870	21
40	9.125187	9.996100	9.129087	10.870913	20
41	9.126125	9.996083	9.130041	10.869959	19
42	9.127060	9.996066	9.130994	10.869006	18
43	9.127993	9.996049	9.131944	10.868056	17
44	9.128925	9.996032	9.132893	10.867107	16
45	9.129854	9.996015	9.133839	[illegible]	15
46	9.130781	9.995998	9.134784	10.865216	14
47	9.131706	9.995980	9.135726	10.864274	13
48	9.132630	9.995963	9.136666	10.863334	12
49	9.133551	9.995946	9.137605	10.862395	11
50	9.134470	9.995928	9.138542	10.861458	10
51	9.135387	9.995911	9.139476	10.860524	9
52	9.136303	9.995894	9.140409	10.859591	8
53	9.137216	9.995876	9.141340	10.858660	7
54	9.138127	9.995859	9.142269	10.857731	6
55	9.139037	9.995841	9.143196	10.856804	5
56	9.139944	9.995825	9.144121	10.855879	4
57	9.140850	9.995806	9.145044	10.854956	3
58	9.141754	9.995788	9.145965	10.854035	2
59	9.142655	9.995770	9.146885	10.853115	1
60	9.142555	9.995753	9.147803	10.852197	0
	Co-sine	Sine	Co-tang.	Tangent	M

Degree 82.

M	Sine	*Co-sine*		Tangent	*Co-tang.*	
0	9.143555	9.995753		9.147803	10.852197	60
1	9.144453	9.995735		9.148718	10.851282	59
2	9.145349	9.995717		9.149632	10.850368	58
3	9.146243	9.995699		9.159544	10.849456	57
4	9.147136	9.995681		9.151454	10.848546	56
5	9.148026	9.995664		9.152363	10.847637	55
6	9.148919	9.995646		9.153269	10.846731	54
7	9.149881	9.995628		9.154174	10.845825	53
8	9.150686	9.995610		9.155077	10.844923	52
9	9.151569	9.995591		9.155978	10.844022	51
10	9.152451	9.995573		9.156877	10.843123	50
11	9.153330	9.995555		9.157775	10.842225	49
12	9.154208	9.995537		9.158671	10.841329	48
13	9.155082	9.995519		9.159565	10.840435	47
14	9.155957	9.995501		9.160457	10.839543	46
15	9.156830	9.995482		9.161347	10.838653	45
16	9.157700	9.995464		9.162236	10.837764	44
17	9.158569	9.995446		9.163123	10.836877	43
18	9.159436	9.995427		9.164008	10.835992	42
19	9.160301	9.995409		9.164892	10.835108	41
20	9.161164	9.995390		9.165773	10.834226	40
21	9.162025	9.995372		9.166654	10.833346	39
22	9.162885	9.995353		9.167532	10.832468	38
23	9.163743	9.995334		9.168409	10.831591	37
24	9.164600	9.995316		9.169284	10.830716	36
25	9.165454	9.995297		9.160157	10.829843	35
26	9.166307	9.995278		9.171029	10.828971	34
27	9.167158	9.995260		9.171899	10.828101	33
28	9.168008	9.995241		9.172767	10.827233	32
29	9.168856	9.995222		9.173634	10.826366	31
30	9.169702	9.995203		9.174499	10.825501	30
	Co-sine	Sine		*Co-tang.*	Tangent	M

M	Sine	Co-sine	Tangent	Co-tang.	
30	9.169702	9.995203	9.174499	10.825501	30
31	9.170546	9.995184	9.175362	10.824638	29
32	9.171389	9.995165	9.176224	10.823776	28
33	9.172230	9.995146	9.177084	10.822916	27
34	9.173070	9.995127	9.177942	10.822057	26
35	9.173908	9.995108	9.178799	10.821201	25
36	9.174744	9.995089	9.179655	10.820345	24
37	9.175578	9.995070	9.180508	10.819492	23
38	9.176411	9.995061	9.181360	10.818640	22
39	9.177242	9.995032	9.182211	10.817789	21
40	9.178072	9.995012	9.183060	10.816940	20
41	9.178900	9.994993	9.183907	10.816093	19
42	9.179726	9.994974	9.184752	10.815248	18
43	9.180551	9.994955	9.185597	10.814403	17
44	9.181374	9.994935	9.186439	10.813561	16
45	9.182196	9.994916	9.187280	10.812720	15
46	9.183016	9.994896	9.188120	10.811880	14
47	9.183834	9.994876	9.188957	10.811042	13
48	9.184651	9.994857	9.189794	10.810206	12
49	9.185466	9.994838	9.190629	10.809371	11
50	9.186280	9.994818	9.191462	10.808538	10
51	9.187092	9.994798	9.192294	10 807706	9
52	9.187903	9.994779	9.193124	10.806876	8
53	9.188712	9.994759	9.193953	10.806047	7
54	9.189519	9.994739	9.194780	10.805220	6
55	9.190325	9.994719	9.195606	10.804394	5
56	9.191130	9.994699	9.196440	10.803569	4
57	9.191933	9.994680	9.197253	10.802747	3
58	9.192734	9.994660	9.198674	10.801926	2
59	9.193534	9.994640	9.198894	10.801106	1
60	9.194332	9.99[illegible]520	9.199712	10.800287	0
	Co-sine	Sine	Co-tang.	Tangent	M

Degree 81.

M	Sine	Co-sine	Tangent	Co-tang.	M
0	9.194332	9.994620	9.199712	10.800287	60
1	9.195129	9.994600	9.200529	10.799470	59
2	9.195925	9.994580	9.201345	10.798655	58
3	9.196718	9.994560	9.202159	10.797841	57
4	9.197511	9.994540	9.202971	10.797029	56
5	9.198302	9.994519	9.203782	10.796218	55
6	9.199091	9.994499	9.204592	10.795408	54
7	9.199879	9.994479	9.205400	10.794600	53
8	9.200666	9.994459	9.206207	10.793793	52
9	9.201451	9.994438	9.207013	10.792987	51
10	9.202234	9.994418	9.207817	10.792183	50
11	9.203017	9.994398	9.208619	10.791381	49
12	9.203797	9.994377	9.209420	10.790580	48
13	9.204577	9.994357	9.210220	10.789780	47
14	9.205354	9.994336	9.211018	10.788982	46
15	9.206131	9.994316	9.211815	10.788185	45
16	9.206906	9.994195	9.212611	10.787385	44
17	9.207679	9.994174	9.213405	10.786595	43
18	9.208452	9.994154	9.214198	10.785802	42
19	9.209222	9.994133	9.214989	10.785011	41
20	9.209992	9.994112	9.215780	10.784220	40
21	9.210760	9.994191	9.216568	10.783432	39
22	9.211526	9.994171	9.217356	10.782644	38
23	9.212291	9.994150	9.218142	10.781858	37
24	9.213055	9.994129	9.218926	10.781070	36
25	9.213818	9.994108	9.219710	10.780294	35
26	9.214579	9.994087	9.220491	10.779508	34
27	9.215338	9.994066	9.221272	10.778728	33
28	9.216097	9.994044	9.222052	10.777948	32
29	9.216854	9.994024	9.222830	10.777170	31
30	9.217609	9.994003	9.2[illegible]607	10.776398	30
	Co-sine	Sine	Co-tang.	Tangent	M

M	Sine	Co-sine		Tangent	Co-tang.	
30	9.217609	9.994003		9.223607	10.716393	30
31	9.218363	9.993982		9.224382	10.775618	29
32	9.219116	9.993960		9.225156	10.774844	28
33	9.219868	9.993939		9.225929	10.774071	27
34	9.220618	9.993918		9.226704	10.773300	26
35	9.221367	9.993897		9.227471	10.772529	25
36	9.222115	9.993875		9.228240	10.771760	24
37	9.222861	9.993854		9.229007	10.770993	23
38	9.223606	9.993832		9.229774	10.770226	22
39	9.224349	9.993811		9.230539	10.769461	21
40	9.225092	9.993789		9.231302	10.768698	20
41	9.225833	9.993768		9.232065	10.767935	19
42	9.226573	9.993746		9.232826	10.767174	18
43	9.227311	9.993725		9.233586	10.766414	17
44	9.228048	9.993703		9.234345	10.765655	16
45	9.228784	9.993681		9.235103	10.764897	15
46	9.239518	9.993660		9.235859	10.764141	14
47	9.230252	9.993638		9.236614	10.763386	13
48	9.230984	9.993616		9.237368	10.762632	12
49	9.231715	9.993594		9.238120	10.761880	11
50	9.232444	9.993572		9.238872	10.761128	10
51	9.233172	9.993550		9.239622	10.760378	9
52	9.233899	9.993528		9.240371	10.759629	8
53	9.234625	9.993506		9.241118	10.758882	7
54	9.235349	9.993484		9.241865	10.758135	6
55	9.236073	9.993462		9.242610	10.757390	5
56	9.236795	9.993440		9.243354	10.756646	4
57	9.237515	9.993418		9.244097	10.755903	3
58	9.238835	9.993396		9.244839	10.755161	2
59	9.238952	9.993374		9.245579	10.754421	1
60	9.239670	9.993351		9.246319	10.753681	0
	Co-sine	Sine		Co-tang.	Tangent	M

Degree 80.

M	Sine	Co-sine	Tangent	Co-tang.	
0	9.239670	9.993351	9.246319	10.753681	60
1	9.240386	9.993329	9.247057	10.752943	59
2	9.241101	9.993307	9.247794	10.752206	58
3	9.241814	9.993284	9.248530	10.751470	57
4	9.242526	9.993262	9.249264	10.750736	56
5	9.243237	9.993240	9.249998	10.750002	55
6	9.243947	9.993117	9.250730	10.749270	54
7	9.244656	9.993195	9.251461	10.748539	53
8	9.245363	9.993172	9.252191	10.747809	52
9	9.246070	9.993149	9.252920	10.747080	51
10	9.246775	9.993127	9.253648	10.746352	50
11	9.247478	9.993104	9.254374	10.745626	49
12	9.248181	9.993011	9.255200	10.744900	48
13	9.248883	9.993059	9.255824	10.744176	47
14	9.249583	9.993036	9.256547	10.743453	46
15	9.250282	9.993013	9.257269	10.742731	45
16	9.250980	9.992990	9.257990	10.742010	44
17	9.251677	9.992967	9.258710	10.741290	43
18	9.252373	9.992944	9.259429	10.740571	42
19	9.253067	9.992921	9.260146	10.739854	41
20	9.253761	9.992898	9.260863	10.739137	40
21	9.254453	9.992875	9.261578	10.738422	39
22	9.255144	9.992852	9.262292	10.737708	38
23	9.255834	9.992829	9.263005	10.736995	37
24	9.256523	9.992806	9.263717	10.736283	36
25	9.257211	9.992783	9.264428	10.735572	35
26	9.257898	9.992759	9.265138	10.734862	34
27	9.258583	9.992736	9.265847	10.734153	33
28	9.259268	9.992713	9.266555	10.733445	32
29	9.259951	9.992690	9.267261	10.732739	31
30	9.260633	9.992666	9.267967	10.732033	30
	Co-sine	Sine	Co-tang.	Tangent	M

Degree 79.

M	Sine	Co-sine	Tangent	Co-tang.	
30	9.260633	9.992666	9.267967	10.732033	30
31	9.261314	9.992643	9.268671	10.731329	29
32	9.261994	9.992619	9.269375	10.730625	28
33	9.262673	9.992596	9.270778	10.729923	27
34	9.263351	9.992572	9.271479	10.729221	26
35	9.264027	9.992549	9.271479	10.728521	25
36	9.264703	9.992525	9.272178	10.727822	24
37	9.265378	9.992501	9.272876	10.727124	23
38	9.266051	9.992478	9.273573	10.726427	22
39	9.266723	9.992454	9.274269	10.725731	21
40	9.267395	9.992430	9.274964	10.725036	20
41	9.268065	9.992406	9.275658	10.724342	19
42	9.268734	9.992382	9.276351	10.723649	18
43	9.269402	9.992362	9.277043	10.722957	17
44	9.270069	9.992335	9.277734	10.722267	16
45	9.270735	9.992311	9.278424	10.721576	15
46	9.271400	9.992287	9.279113	10.720887	14
47	9.272063	9.992263	9.279801	10.720199	13
48	9.272726	9.992239	9 280488	10.719512	12
49	9.273388	9.992214	9.281174	10.718826	11
50	9.274049	9.992190	9.281858	10.718142	10
51	9.274708	9 992166	9.282542	10.717458	9
52	9.275367	9.992142	9.283225	10.716775	8
53	9.276025	9.992118	9283907	10.716093	7
54	9.276681	9.992093	9.284588	10.715412	6
55	9.277337	9.992069	9.285268	10.714732	5
56	9.277991	9.992045	9.285946	10.714053	4
57	9.278685	9.992020	9.286624	10.713376	3
58	9.279297	9.991996	9.287301	10.712699	2
59	9.279948	9.991971	9.287977	10.712023	1
60	9.280599	9.991947	9.288652	10.711348	0
	Co-sine	Sine	Co-tang.	Tangent	M

Degree 79.

M	Sine	Co-sine	Tangent	Co-tang.	
0	9.280599	9.991947	9.288652	10.711348	60
1	9.281229	9.991922	9.289326	10.710674	59
2	9.281897	9.991897	9.289999	10.710001	58
3	9.282544	9.991873	9.290671	10.709329	57
4	9.283190	9.991848	9.291342	10.708658	56
5	9.283836	9.991823	9.292013	10.707987	55
6	9.284480	9.991799	9.292682	10.707318	54
7	9.285124	9.991774	9.293350	10.706650	53
8	9.285766	9.991749	9.294017	10.705983	52
9	9.286408	9.991724	9.294684	10.705316	51
10	9.287048	9.991699	9.295349	10.704651	50
11	9.287688	9.991674	9.296013	10.703987	49
12	9.288326	9.991649	9.296677	10.703323	48
13	9.288964	9.991624	9.297339	10.702661	47
14	9.289600	9.991599	9.298001	10.701999	46
15	9.290236	9.991574	9.298662	10.701338	45
16	9.290870	9.991549	9.299322	10.700678	44
17	9.291504	9.991524	9.299980	10.700020	43
18	9.292137	9.991498	9.300638	10.699362	42
19	9.292768	9.991473	9.301295	10.698705	41
20	9.293399	9.991448	9.301951	10.698049	40
21	9.294029	9.991422	9.302607	10.697393	39
22	9.294658	9.991397	9.303261	10.696739	38
23	9.295286	9.991372	9.303914	10.696086	37
24	9.295913	9.991346	9.304567	10.695433	36
25	9.296539	9.991321	9.305218	10.694782	35
26	9.297164	9.991295	9.305867	10.694131	34
27	9.297788	9.991270	9.306519	10.693481	33
28	9.298412	9.991244	9.307168	10.692832	32
29	9.299034	9.991218	9.307816	10.692184	31
30	9.299655	9.991193	9.308463	10.691537	30
	Co-sine	Sine	Co-tang.	Tangent	M

Degree 78.

M	Sine	*Co-sine*	Tangent	*Co-tang.*	
30	9.299655	9.991193	9.308463	10.691537	30
31	9.300276	9.991167	9.309109	10.690891	29
32	9.300895	9.991141	9.309754	10.690246	28
33	9.301514	9.991115	9.310399	10.689601	27
34	9.302132	9.991090	9.311042	10.688958	26
35	9.302749	9.991064	9.311685	10.688315	25
36	9.303364	9.991038	9.312327	10.687673	24
37	9.303979	9.991012	9.312968	10.687032	23
38	9.304593	9.990986	9.313608	10.686392	22
39	9.305207	9.990960	9.314247	10.685753	21
40	9.305819	9.990934	9.314885	10.685115	20
41	9.306430	9.990908	9.315523	10.684477	19
42	9.307041	9.990882	9.316159	10.683841	18
43	9.307650	9.990855	9.316795	10.683205	17
44	9.308259	9.990829	9.317430	10.682570	16
45	9.308867	9.990803	9.318064	10.681936	15
46	9.309474	9.990777	9.318647	10.681303	14
47	9.310080	9.990750	9.319330	10.680670	13
48	9.310685	9.990724	9.319961	10.680039	12
49	9.311289	9.990697	9.320592	10.679408	11
50	9.311899	9.990671	9.321222	10.678778	10
51	9.312495	9.990645	9.321851	10.678149	9
52	9.313097	9.990618	9.322479	10.677521	8
53	9.313698	9.990591	9.323106	10.676894	7
54	9.314297	9.990565	9.323733	10.676267	6
55	9.314897	9.990538	9.324358	10.675642	5
56	9.315495	9.990512	9.324983	10.675017	4
57	9.316092	9.990485	9.325607	10.674393	3
58	9.316689	9.990458	9.326231	10.673769	2
59	9.317284	9.990431	9.326853	10.673147	1
60	9.317879	9.990404	9.327475	10.672525	0
	Co-sine.	Sine	*Co-tang.*	Tangent	M

M	Sine	*Co-sine*	Tangent	*Co-tang.*	
0	9.317879	9.990404	9.327475	10.672525	60
1	9.318473	9.990377	9.328095	10.671905	59
2	9.319066	9.990351	9.328715	10.671285	58
3	9.319658	9.990324	9.329334	10.670666	57
4	9.320250	9.990297	9.329953	10.670047	56
5	9.320840	9.990270	9.320570	10.669430	55
6	9.321430	9.990242	9.331187	10.668813	54
7	9.322019	9.990215	9.331803	10.668197	53
8	9.322607	9.990188	9.332418	10.667582	52
9	9.323194	9.990161	9.333033	10.666967	51
10	9.323780	9.990134	9.333646	10.666354	50
11	9.324366	9.990107	9.334259	10.665741	49
12	9.324950	9.990079	9.334871	10.665129	48
13	9.325534	9.990052	9.335482	10.664518	47
14	9.326117	9.990025	9.336093	10.663907	46
15	9.326699	9.989997	9.336700	10.663298	45
16	9.327281	9.989970	9.337311	10.662689	44
17	9.327862	9.989942	9.337919	10.662081	43
18	9.328441	9.989915	9.338527	10.661473	42
19	9.329020	9.989887	9.339133	10.660867	41
20	9.329599	9.989860	9.339739	10.660261	40
21	9.330176	9.989832	9.340344	10.659656	39
22	9.330753	9.989804	9.340948	10.659052	38
23	9.331328	9.989777	9.341552	10.658448	37
24	9.331903	9.989749	9.342155	10.657845	36
25	9.332478	9.989721	9.342757	10.657243	35
26	9.333051	9.989693	9.343358	10.656642	34
27	9.333624	9.989665	9.343958	10.656042	33
28	9.334195	9.989637	9.344558	10.655442	32
29	9.334766	9.989609	9.345157	10.654843	31
30	9.335337	9.989581	9.345755	10.654245	30
	Co-sine	Sine	*Co-tang.*	Tangent.	M

Degree 77.

M	Sine	*Co-sine*		Tangent	*Co-tang.*	
30	9.335337	9.989581		9.345755	10.654245	30
31	9.335906	9.989553		9.346353	10.653647	29
32	9.336475	9.989525		9.346949	10.653051	28
33	9.337043	9.989597		9.347545	10.652455	27
34	9.337610	9.989469		9.348141	10.651859	26
35	9.338176	9.989441		9.348735	10.651265	25
36	9.338742	9.989413		9.349329	10.650671	24
37	9.339306	9.989384		9.349922	10.650078	23
38	9.339870	9.989356		9.350514	10.649486	22
39	9.340434	9.989328		9.351106	10.648894	21
40	9.340996	9.989299		9.351697	10.648303	20
41	9.341558	9.989271		9.352287	10.647713	19
42	9.342119	9.989243		9.352876	10.647124	18
43	9.342679	9.989214		9.353465	10.646535	17
44	9.343239	9.989186		9.354053	10.645947	16
45	9.343797	9.989157		9.354640	10.645360	15
46	9.344355	9.989128		9.355227	10.644773	14
47	9.344912	9.989100		9.355812	10.644187	13
48	9.345469	9.989071		9.356398	10.643602	12
49	9.346024	9.989042		9.356982	10.643018	11
50	9.346579	9.989014		9.357566	10.642434	10
51	9.347134	9.988985		9.358149	10.641851	9
52	9.347687	9.988956		9.358731	10.641269	8
53	9.348240	9.988927		9.359313	10.640687	7
54	9.348792	9.988898		9.359893	10.640107	6
55	9.349343	9.988869		9.360474	10.639526	5
56	9.349893	9.988840		9.361053	10.638947	4
57	9.350443	9.988811		9.361632	10.638368	3
58	9.350992	9.988782		9.362210	10.637790	2
59	9.351540	9.988754		9.362787	10.637213	1
60	9.352088	9.988724		9.363364	10.636636	0
	Co-sine.	Sine		*Co-tang.*	Tangent.	M

M	Sine	Co-sine	Tangent	Co-tang.	
0	9.352088	9.988724	9.363364	10.636636	60
1	9.352635	9.988695	9.363940	10.636060	59
2	9.353181	9.988666	9.364515	10.635485	58
3	9.353726	9.988636	9.365090	10.634910	57
4	9.354271	9.988607	9.365664	10.634336	56
5	9.354185	9.988578	9.366237	10.633763	55
6	9.355358	9.988548	9.366810	10.633190	54
7	9.355901	9.988519	9.367382	10.632618	53
8	9.356443	9.988489	9.367953	10.632047	52
9	9.356984	9.988460	9.368524	10.631476	51
10	9.357524	9.988430	9.369094	10.630906	50
11	9.358064	9.988401	9.369663	10.630337	49
12	9.358603	9.988371	9.370232	10.629768	48
13	9.359141	9.988341	9.370799	10.629201	47
14	9.359679	9.988312	9.371367	10.628633	46
15	9.350215	9 988282	9.371933	10.628067	45
16	9.360752	9 988252	9.372499	10.627501	44
17	9.361287	9.988223	9.373064	10.626936	43
18	9.361822	9.988193	9.373629	10.626371	42
19	9 362356	9.988163	9.374193	10.625807	41
20	9.362889	9.988133	9.374756	10.625244	40
21	9.363422	9.988103	9.375319	10.624681	39
22	9.363954	9.988073	9.375881	10.624119	38
23	9.364485	9.988043	9.376442	10.623558	37
24	9.365016	9.988013	9.377003	10.622997	36
25	9.365546	9.987983	9.377563	10.622437	35
26	9.366075	9.987953	9.378122	10.621878	34
27	9.366604	9.987922	9.378681	10.621319	33
28	9.367132	9.987892	9.379239	10.620761	32
29	9.367659	9.987862	9.379797	10.620203	31
30	9.368185	9.987832	9.380354	10.619646	30
	Co-sine	Sine	Co-tang.	Tangent	M

M	Sine	Co-fine	Tangent	Co-tang.	M
30	9.368185	9.987832	9.380354	10.619646	30
31	9.368711	9.987801	9.380910	10.619090	29
32	9.369236	9.987771	9.381466	10.618534	28
33	9.369761	9.987740	9.382021	10.617980	27
34	9.370285	9.987710	9.382575	10.617425	26
35	9.370808	9.987679	9.383129	10.616871	25
36	9.371330	9.987649	9.383682	10.616318	24
37	9.371852	9.987618	9.384234	10.615766	23
38	9.372373	9.987588	9.384786	10.615214	22
39	9.372894	9.987557	9.385337	10.614663	21
40	9.373414	9.987526	9.385888	10.614112	20
41	9.373933	9.987496	9.386438	10.613562	19
42	9.374452	9.987465	9.386987	10.613013	18
43	9.374970	9.987434	9.387536	10.612464	17
44	9.375487	9.987403	9.388084	10.611916	16
45	9.376003	9.987372	9.388631	10.611369	15
46	9.376519	9.987341	9.389178	10.610822	14
47	9.377035	9.987310	9.389724	10.610276	13
48	9.377549	9.987279	9.390270	10.609730	12
49	9.378063	9.987248	9.390815	10.609185	11
50	9.378577	9.987217	9.391360	10.608640	10
51	9.379089	9.987186	9.391907	10.608097	9
52	9.379601	9.987155	9.392467	10.607553	8
53	9.380113	9.987124	9.392989	10.607011	7
54	9.380624	9.987092	9.393531	10.606469	6
55	9.381134	9.987061	9.394074	10.605927	5
56	9.381643	9.987030	9.394614	10.605386	4
57	9.382152	9.986998	9.395154	10.604846	3
58	9.382661	9.986967	9.395694	10.604306	2
59	9.383168	9.986936	9.396233	10.603767	1
60	9.383675	9.986904	9.396770	10.603229	0
M	Co-fine	Sine	Co-tang.	Tangent	M

M	Sine	Co-sine	Tangent	Co-tang.	
0	9.383675	9.986904	9.396771	10.603229	60
1	9.384181	9.986873	9.397309	10.602694	59
2	9.384687	9.986841	9.397846	10.602154	58
3	9.385192	9.986809	9.398383	10.601617	57
4	9.385697	9.986778	9.398919	10.601081	56
5	9.386201	9.986746	9.399455	10.600545	55
6	9.386704	9.986714	9.399990	10.600010	54
7	9.387207	9.986683	9.400524	10.599476	53
8	9.387709	9.986651	9.401058	10.598942	52
9	9.388210	9.986619	9.401591	10.598409	51
10	9.388711	9.986587	9.402124	10.597876	50
11	9.389211	9.986555	9.402656	10.597344	49
12	9.389711	9.986523	9.403187	10.596813	48
13	9.390210	9.986491	9.403718	10.596282	47
14	9.390708	9.986459	9.404249	10.595751	46
15	9.391206	9.986427	9.404778	10.595222	45
16	9.391703	9.986395	9.405306	10.594692	44
17	9.392199	9.986363	9.405836	10.594164	43
18	9.392695	9.986331	9.406364	10.593636	42
19	9.393190	9.986299	9.406892	10.593608	41
20	9.393685	9.986266	9.407419	10.592581	40
21	9.394179	9.986234	9.407945	10.592055	39
22	9.394673	9.986201	9.408471	10.591529	38
23	9.395166	9.986869	9.408996	10.591001	37
24	9.395654	9.986137	9.409521	10.590479	36
25	9.396150	9.986104	9.410045	10.589954	35
26	9.396641	9.986072	9.410569	10.589431	34
27	9.397131	9.986039	9.411097	10.588908	33
28	9.397621	9.986007	9.411615	10.588385	32
29	9.398111	9.985974	9.412137	10.587863	31
30	9.398600	9.986942	9.412658	10.587342	30
	Co-sine	Sine	Co-tang.	Tangent	M

M	Sine	Co-sine	Tangent	Co-tang.	
30	9.398600	9.985942	9.412658	10.587342	30
31	9.399087	9.985909	9.413179	10.586821	29
32	9.399575	9.985876	9.413699	10.586301	28
33	9.400062	9.985843	9.414219	10.585781	27
34	9.400549	9.985811	9.414738	10.585262	26
35	9.401035	9.985778	9.415257	10.584742	25
36	9.401520	9.985745	9.415775	10.584225	24
37	9.402005	9.985712	9.416293	10.583707	23
38	9.402489	9.985679	9.416810	10.583190	22
39	9.402972	9.985646	9.417326	10.582674	21
40	9.403455	9.985613	9.417842	10.582157	20
41	9.403938	9.985580	9.418357	10.581642	19
42	9.404420	9.985547	9.418873	10.581127	18
43	9.404901	9.985513	9.419387	10.580613	17
44	9.405382	9.985480	9.419901	10.580099	16
45	9.405862	9.985447	9.420415	10.579585	15
46	9.406341	9.985414	9.420927	10.579072	14
47	9.406820	9.985380	9.421440	10.578560	13
48	9.407299	9.985347	9.421951	10.578048	12
49	9.407776	9.985314	9.422463	10.577537	11
50	9.408254	9.985280	9.422973	10.577026	10
51	9.408731	9.985247	9.423484	10.576516	9
52	9.409207	9.985213	9.423993	10.576007	8
53	9.409682	9.985180	9.424503	10.575497	7
54	9.410157	9.985146	9.425011	10.574989	6
55	9.410632	9.985112	9.425518	10.574480	5
56	9.411106	9.985079	9.426027	10.573973	4
57	9.411579	9.985045	9.426534	10.573466	3
58	9.412052	9.985011	9.427041	10.572959	2
59	9.412524	9.984977	9.427547	10.572453	1
60	9.412996	9.984943	9.428052	10.571947	0
	Co-sine	Sine	Co-tang.	Tangent	M

M	Sine	Co-sine	Tangent	Co-tang.	
0	9.412996	9.984944	9.428052	10.571947	60
1	9.413467	9.984910	9.428557	10.571442	59
2	9.413938	9.984876	9.429067	10.570938	58
3	9.414408	9.984842	9.429566	10.570434	57
4	9.414878	9.984808	9.430070	10.569930	56
5	9.415347	9.984774	9.430573	10.569427	55
6	9.415815	9.984740	9.431075	10.568925	54
7	9.416283	9.984706	9.431577	10.568423	53
8	9.416850	9.984672	9.432079	10.567921	52
9	9.417217	9.984637	9.432580	10.567420	51
10	9.417684	9.984603	9.433080	10.566920	50
11	9.418149	9.984569	9.433580	10.566419	49
12	9.418615	9.984535	9.434080	10.565920	48
13	9.419079	9.984500	9.434579	10.565421	47
14	9.419544	9.984466	9.435078	10.564922	46
15	9.420007	9.984431	9.435576	10.564424	45
16	9.420470	9.984397	9.436073	10.563927	44
17	9.420933	9.984363	9.436570	10.563430	43
18	9.421395	9.984328	9.437067	10.562933	42
19	9.421856	9.984293	9.437563	10.562437	41
20	9.422317	9.984259	9.438059	10.561941	40
21	9.422778	9.984224	9.438554	10.561446	39
22	9.423238	9.984189	9.439548	10.560952	38
23	9.423697	9.984155	9.439543	10.560457	37
24	9.424156	9.984120	9.440036	10.559964	36
25	9.424615	9.984085	9.440529	10.559471	35
26	9.425072	9.984050	9.441022	10.558978	34
27	9.425530	9.984015	9.441514	10.558486	33
28	9.425987	9.983980	9.442006	10.557994	32
29	9.426443	9.983945	9.442497	10.557503	31
30	9.426899	9.983910	9.442988	10.557011	30
	Co-sine	Sine	Co-tang.	Tangent	M

M	Sine	Co-sine	Tangent	Co-tang.	
30	9.426899	9.983910	9.442988	10.557011	30
31	9.427354	9.983875	9.443479	10.556521	29
32	9.427809	9.983840	9.443968	10.556031	28
33	9.428264	9.983805	9.444458	10.555542	27
34	9.428717	9.983770	9.444947	10.555035	26
35	9.429170	9.983735	9.445435	10.554565	25
36	9.429623	9.983699	9.445923	10.554077	24
37	9.430075	9.983664	9.446411	10.553589	23
38	9.430507	9.983629	9.446898	10.553102	22
39	9.430978	9.983593	9.447384	10.552616	21
40	9.431429	9.983558	9.447870	10.552129	20
41	9.431879	9.983523	9.448356	10.551644	19
42	9.432328	9.983487	9.448841	10.551159	18
43	9.432778	9.983452	9.449326	10.550674	17
44	9.433206	9.983416	9.449810	10.550181	16
45	9.433674	9.983380	9.450294	10.559706	15
46	9.434122	9.983345	9.450777	10.549223	14
47	9.434569	9.983309	9.451260	10.548740	13
48	9.435016	9.983273	9.451743	10.548257	12
49	9.435462	9.983238	9.452225	10.547775	11
50	9.435918	9.983202	9.452706	10.547294	10
51	9.436353	9.983166	9.453187	10.546813	9
52	9.436798	9.983130	9.453668	10.546332	8
53	9.437242	9.983094	9.454148	10.545852	7
54	9.437686	9.983058	9.454629	10.545372	6
55	9.438129	9.983022	9.455107	10.544893	5
56	9.438572	9.982986	9.455586	10.544414	4
57	9.439014	9.982950	9.456064	10.543936	3
58	9.439456	9.982914	9.456542	10.543458	2
59	9.439897	9.982878	9.457019	10.542980	1
60	9.440338	9.982842	9.457496	10.542503	0
	Co-sine	Sine	Co-tang.	Tangent	M

Degree 74.

M	Sine	*Co-sine*	Tangent	*Co-tang.*	
0	9.440338	9.982842	9.457496	10.542503	60
1	9.440778	9.982805	9.457973	10.542027	59
2	9.441218	9.982769	9.458449	10.541551	58
3	9.441658	9.982733	9.458925	10.541075	57
4	9.442096	9.982696	9.459400	10.540600	56
5	9.442535	9.982660	9.459875	10.540125	55
6	9.442973	9.982623	9.460349	10.539651	54
7	9.443416	9.982587	9.460829	10.539177	53
8	9.443848	9.982550	9.461297	10.538703	52
9	9.444284	9.982514	9.461770	10.538230	51
10	9.444720	9.982477	9.462242	10.537758	50
11	9.445155	9.982441	9.462714	10.537285	49
12	9.445590	9.982404	9.463186	10.536814	48
13	9.446025	9.982367	9.463658	10.536342	47
14	9.446459	9.982330	9.464129	10.535871	46
15	9.446893	9.982294	9.464599	10.535401	45
16	9.447326	9.982257	9.465069	10.534931	44
17	9.447759	9.982220	9.465539	10.534461	43
18	9.448191	9.982183	9.466008	10.533992	42
19	9.448623	9.982146	9.466476	10.533523	41
20	9.449054	9.982109	9.466945	10.533055	40
21	9.449485	9.982072	9.467413	10.532587	39
22	9.449915	9.982035	9.467880	10.532120	38
23	9.450345	9.981998	9.468347	10.531653	37
24	9.450775	9.981961	9.468814	10.531186	36
25	9.451203	9.981923	9.469280	10.530720	35
26	9.451632	9.981886	9.469746	10.530254	34
27	9.452060	9.981849	9.470211	10.529789	33
28	9.452488	9.981812	9.470676	10.529324	32
29	9.452915	9.981774	9.471141	10.528859	31
30	9.453342	9.581737	9.471605	10.528395	30
	Co-sine	Sine	*Co-tang.*	Tangent	M

M	Sine	Co-sine	Tangent	Co-tang.	
30	9.453342	9.981737	9.471605	10.528395	30
31	9.453768	9.981699	9.472068	10.527931	29
32	9.454194	9.981662	9.472532	10.527468	28
33	9.454619	9.981624	9.472995	10.527005	27
34	9.455044	9.981587	9.473457	10.526543	26
35	9.455469	9.981549	9.473919	10.526081	25
36	9.455892	9.981512	9.474381	10.525619	24
37	9.456316	9.981474	9.474842	10.525158	23
38	9.456739	9.981436	9.475303	10.524695	22
39	9.457162	9.981398	9.475763	10.524237	21
40	9.457584	9.981361	9.476223	10.523777	20
41	9.458006	9.981323	9.476683	10.523317	19
42	9.458427	9.981285	9.477142	10.522858	18
43	9.458848	9.981247	9.477601	10.522399	17
44	9.459268	9.981209	9.478059	10.521941	16
45	9.459684	9.981171	9.478517	10.521483	15
46	9.460108	9.981133	9.478975	10.521025	14
47	9.460527	9.981095	9.479432	10.520168	13
48	9.460946	9.981057	9.479886	10.520111	12
49	9.461364	9.981019	9.480345	10.519655	11
50	9.461782	9.980980	9.480801	10.519199	10
51	9.462199	9.980942	9.481257	10.518743	9
52	9.462616	9.980904	9.481712	10.518288	8
53	9.463032	9.980866	9.482167	10.517833	7
54	9.463448	9.980827	9.482621	10.517379	6
55	9.463864	9.980789	9.483075	10.516925	5
56	9.464279	9.980750	9.483528	10.516471	4
57	9.464694	9.980712	9.483982	10.516018	3
58	9.465108	9.980672	9.484434	10.515565	2
59	9.465522	9.980635	9.484887	10.515113	1
60	9.465935	9.980596	9.485339	10.514661	0
	Co-sine	Sine	Co-tang.	Tangent	M

Degree 73.

M	Sine	*Co-sine*	Tangent	*Co-tang.*	
0	9.465935	9.980596	9.485339	10.514661	60
1	9.466348	9.980558	9.485791	10.514209	59
2	9.466761	9.980519	9.486272	10.513758	58
3	9.467173	9.980480	9.486693	10.513307	57
4	9.467585	9.980441	9.487143	10.512857	56
5	9.467996	9.980403	9.487593	10.512407	55
6	9.468407	9.980364	9.488043	10.511957	54
7	9.468817	9.980325	9.488493	10.511507	53
8	9.469227	9.98c286	9.488941	10.511059	52
9	9.469637	9.980247	9.489390	10.510610	51
10	9.460446	9.980208	9.489838	10.510162	50
11	9.470455	9.980169	9.490286	10.509714	49
12	9.471863	9.980130	9.490733	10.5c9267	48
13	9.471071	9.980091	9.491180	10.508820	47
14	9.471678	9.980052	9.491627	10.508373	46
15	9.472086	9.980012	9.492073	10.507928	45
16	9.472492	9.979973	9.492519	10.507481	44
17	9.472898	9.979934	9.492964	10.507035	43
18	9.473304	9.979894	9.493410	10.5c6590	42
19	9.473710	9.979855	9.493854	10.506145	41
20	9.474115	9.979816	9.494299	10.505701	40
21	9.474519	9.979776	9.494743	10.505257	39
22	9.474923	9.979737	9.495186	10.504813	38
23	9.475327	9.979697	9.495630	10.504370	37
24	9.475730	9.979658	9.496073	10.503928	36
25	9.476133	9.979618	9.496515	10.503485	35
26	9.476539	9.979578	9.496957	10.503043	34
27	9.476938	9.979539	9.497399	10.502601	33
28	9.477340	9.979499	9.497840	10.502160	32
29	9.477741	9.979459	9.498282	10.501718	31
30	9.478142	9.979419	9.498722	10.501278	30
	Co-sine	Sine	*Co-tang.*	Tangent	M

M	Sine	*Co-sine*		Tangent	*Co-tang.*	
30	9.478142	9.979419		9.498722	10.501278	30
31	9.478542	9.979380		9.499163	10.500837	29
32	9.478942	9.979340		9.499602	10.500398	28
33	9.479342	9.979300		9.500042	10.499958	27
34	9.479741	9.979260		9.500481	10.499519	26
35	9.480140	9.979220		9.500920	10.499080	25
36	9.480538	9.979180		9.501359	10.498641	24
37	9.480936	9.979140		9.501797	10.498203	23
38	9.481334	9.979099		9.502234	10.497765	22
39	9.481731	9.979059		9.502672	10.497328	21
40	9.482128	9.979019		9.503109	10.496891	20
41	9.482525	9.978980		9.503546	10.496454	19
42	9.482921	9.978937		9.503982	10.496018	18
43	9.483316	9.978898		9.504418	10.495582	17
44	9.483711	9.978858		9.504854	10.495146	16
45	9.484106	9.978817		9.505289	10.494711	15
46	9.484501	9.978777		9.505724	10.494216	14
47	9.484895	9.978736		9.506158	10.493841	13
48	9.485289	9.978696		9.506593	10.493407	12
49	9.485682	9.978655		9.507026	10.492973	11
50	9.486075	9.978615		9.507459	10.492540	10
51	9.486467	9.978574		9.507892	10.492107	9
52	9.486859	9.978533		9.508326	10.491674	8
53	9.487251	9.978493		9.508759	10.491241	7
54	9.487642	9.978452		9.509181	10.490809	6
55	9.488033	9.978411		9.509622	10.490377	5
56	9.488424	9.978370		9.510044	10.489946	4
57	9.488814	9.978329		9.510486	10.489515	3
58	9.489204	9.978288		9.510916	10.489084	2
59	9.489593	9.978247		9.511346	10.488654	1
60	9.489982	9.978206		9.511776	10.488225	0
	Co-sine	Sine		*Co-tang.*	Tangent	M

Degree 72.

M	Sine	Co-sine	Tangent	Co-tang.	
0	9.489982	9.978206	9.511776	10.488224	60
1	9.490371	9.978165	9.512206	10.487794	59
2	9.490759	9.978124	9.512635	10.487365	58
3	9.491147	9.978083	9.513064	10.486936	57
4	9.491534	9.978042	9.513493	10.486507	56
5	9.491922	9.978000	9.513921	10.486079	55
6	9.492308	9.977959	9.514349	10.485651	54
7	9.492695	9.977918	9.514777	10.485223	53
8	9.493080	9.977877	9.515204	10.484796	52
9	9.493466	9.977835	9.515631	10.484369	51
10	9.493851	9.977794	9.516057	10.483942	50
11	9.494236	9.977752	9.516484	10.483516	49
12	9.494620	9.977711	9.516910	10.483090	48
13	9.495005	9.977669	9.517335	40.482665	47
14	9.495388	9.977628	9.517761	10.482239	46
15	9.495771	9.977586	9.518185	10.481814	45
16	9.496154	9.977544	9.518610	10.481390	44
17	9.496537	9.977503	9.519034	10.480966	43
18	9.496919	9.977461	9.519458	10.480542	42
19	9.497301	9.977419	9.519882	10.480118	41
20	9.497682	9.977377	9.520305	10.489695	40
21	9.498063	9.977335	9.520728	10.479272	39
22	9.498444	9.977293	9.521151	10.478849	38
23	9.498824	9.977251	9.521573	10.478427	37
24	9.499204	9.977209	9.521995	10.478005	36
25	9.499584	9.977167	9.522417	10.477583	35
26	9.499963	9.977125	9.522838	10.477162	34
27	9.500342	9.977083	9.523259	10.476741	33
28	9.500720	9.977041	9.523679	10.476320	32
29	9.501099	9.977999	9.524109	10.475900	31
30	9.501476	9.977956	9.524520	10.475480	30
	Co-sine	Sine	Co-tang.	Tangent	M

M	Sine	Co-sine	Tangent	Co-tang.	
30	9.501476	9.976956	9.524520	10.475480	30
31	9.501854	9.976914	9.524939	10.475060	29
32	9.502231	9.976872	9.525359	10.474641	28
33	9.502607	9.976830	9.525778	10.474222	27
34	9.502984	9.976787	9.526197	10.473803	26
35	9.503360	9.976745	9.526615	10.473385	25
36	9.503735	9.976702	9.527033	10.472967	24
37	9.504110	9.976660	9.527451	10.472549	23
38	9.504485	9.976617	9.527868	10.472132	22
39	9.504840	9.976574	9.528285	10.471715	21
40	9.505234	9.976532	9.528702	10.471298	20
41	9.505608	9.976489	9.529118	10.470881	19
42	9.505981	9.976446	9.529535	10.470465	18
43	9.506354	9.976404	9.529950	10.470049	17
44	9.506727	9.976361	9.530366	10.469634	16
45	9.507099	9.976318	9.530781	10.469219	15
46	9.507471	9.976275	9.531196	10.468804	14
47	9.507843	9.976232	9.531611	10.468389	13
48	9.508214	9.976185	9.532025	10.467975	12
49	9.508585	9.976146	9.532436	10.467561	11
50	9.508955	9.976103	9.532852	10.467147	10
51	9.509326	9.976060	9.533266	10.466734	9
52	9.509696	9.976017	9.533679	10.466321	8
53	9.510065	9.975973	9.534092	10.465908	7
54	9.510434	9.975930	9.534504	10.465496	6
55	9.510803	9.975887	9.534916	10.465084	5
56	9.511171	9.975844	9.535328	10.464672	4
57	9.511540	9.975800	9.535739	10.464261	3
58	9.511907	9.975757	9.536150	10.463849	2
59	9.512275	9.975713	9.536561	10.463439	1
60	9.512642	9.975670	9.536972	10.463028	0
	Co-sine	Sine	Co-tang	Tangent	M

Degree 71.

M	Sine	Co-sine	Tangent	Co-tang.	
0	9.512642	9.975670	9.536972	10.463028	60
1	9.513009	9.975626	9.537382	10.462618	59
2	9.513375	9.975583	9.537792	10.462208	58
3	9.513741	9.975539	9.538202	10.461798	57
4	9.514107	9.975496	9.538610	10.461389	56
5	9.514472	9.975452	9.539020	10.460980	55
6	9.514837	9.975408	9.539429	10.460571	54
7	9.515202	9.975364	9.539837	10.460163	53
8	9.515566	9.975321	9.540245	10.459755	52
9	9.515930	9.975277	9.540653	10.459347	51
10	9.516294	9.975233	9.541061	10.458939	50
11	9.516657	9.975189	9.541468	10.458532	49
12	9.517020	9.975145	9.541875	10.458125	48
13	9.517382	9.975101	9.542281	10.457719	47
14	9.517745	9.975057	9.542688	10.457312	46
15	9.518107	9.975013	9.543094	10.456906	45
16	9.518468	9.974969	9.543499	10.456501	44
17	9.518829	9.974925	9.543905	10.456095	43
18	9.519190	9.974880	9.544310	10.455690	42
19	9.519551	9.974836	9.544715	10.455285	41
20	9.519911	9.974792	9.545119	10.454881	40
21	9.520271	9.974747	9.545524	10.454476	39
22	9.520631	9.974703	9.545927	10.454072	38
23	9.520990	9.974659	9.546331	10.453669	37
24	9.521349	9.974614	9.546735	10.453265	36
25	9.521707	9.974570	9.547138	10.452862	35
26	9.522065	9.974525	9.547540	10.452459	34
27	9.522423	9.974480	9.547943	10.452057	33
28	9.522781	9.974436	9.548345	10.451655	32
29	9.523138	9.974391	9.548747	10.451253	31
30	9.523495	9.974346	9.549149	10.450851	30
	Co-sine	Sine	Co-tang.	Tangent	M

Degree 70.

M	Sine	Co-sine	Tangent	Co-tang.	
30	9.523495	9.974346	9.549149	10.450851	30
31	9.523851	9.974302	9.549550	10.450450	29
32	9.524208	9.974257	9.549951	10.450049	28
33	9.524564	9.974212	9.550352	10.449648	27
34	9.524920	9.974167	9.550752	10.449248	26
35	9.525275	9.974122	9.551152	10.448848	25
36	9.525630	9.974077	9.551552	10.448448	24
37	9.525984	9.974032	9.551952	10.448048	23
38	9.526339	9.973987	9.552351	10.447649	22
39	9.526693	9.973942	9.552750	10.447250	21
40	9.527046	9.973897	9.553149	10.446851	20
41	9.527400	9.973852	9.553548	10.446452	19
42	9.527753	9.973807	9.553946	10.446054	18
43	9.528105	9.973761	9.554344	10.445656	17
44	9.528458	9.973716	9.554741	10.445259	16
45	9.528810	9.973671	9.555139	10.444861	15
46	9.529161	9.973615	9.555536	10.444464	14
47	9.529513	9.973580	9.555932	10.444068	13
48	9.529864	9.973535	9.556329	10.443671	12
49	9.530214	9.973489	9.556727	10.443275	11
50	9.530565	9.973443	9.557121	10.442879	10
51	9.530915	9.973398	9.557517	10.442483	9
52	9.531265	9.973352	9.557912	10.442088	8
53	9.531614	9.973307	9.558308	10.441693	7
54	9.531963	9.973261	9.558702	10.441298	6
55	9.532312	9.973215	9.559097	10.440903	5
56	9.532661	9.973169	9.559491	10.440509	4
57	9.533009	9.973123	9.559885	10.440115	3
58	9.533357	9.973078	9.560279	10.439721	2
59	9.533704	9.973032	9.560673	10.439327	1
60	9.534052	9.972986	9.561066	10.438934	0
	Co-sine.	Sine	Co-tang.	Tangent	M

M	Sine	*Co-sine*	Tangent	*Co-tang.*	
0	9.534052	9.972986	9.561066	10.438934	60
1	9.534399	9.972940	9.561459	10.438541	59
2	9.534746	9.972894	9.561851	10.438148	58
3	9.535091	9.972848	9.562244	10.437756	57
4	9.535437	9.972801	9.562636	10.437364	56
5	9.535782	9.972755	9.563028	10.436972	55
6	9.536129	9.972709	9.563419	10.436580	54
7	9.536474	9.972663	9.563811	10.436189	53
8	9.536818	9.972617	9.564202	10.435798	52
9	9.537163	9.972570	9.564592	10.435407	51
10	9.537507	9.972524	9.564983	10.435017	50
11	9.537851	9.972477	9.565373	10.434627	49
12	9.538194	9.972431	9.565763	10.434237	48
13	9.538537	9.972384	9.566153	10.433847	47
14	9.538880	9.972338	9.566542	10.433457	46
15	9.539222	9.972291	9.566932	10.433068	45
16	9.539565	9.972245	9.567320	10.432679	44
17	9.539907	9.972198	9.567709	10.432291	43
18	9.540249	9.972151	9.568097	10.431902	42
19	9.540590	9.972105	9.568486	10.431514	41
20	9.540931	9.972058	9.569873	10.431126	40
21	9.541272	9.972011	9.569261	10.430739	39
22	9.541612	9.971964	9.569648	10.430351	38
23	9.541953	9.971917	9.570035	10.429964	37
24	9.542292	9.971870	9.570422	10.429578	36
25	9.542632	9.971823	9.570809	10.429191	35
26	9.542971	9.971776	9.571195	10.428805	34
27	9.543310	9.971729	9.571581	10.428419	33
28	9.543649	9.971682	9.571967	10.428033	32
29	9.543987	9.971635	9.572352	10.427648	31
30	9.544325	9.971588	9.572738	10.427262	30
	Co-sine.	Sine	*Co-tang.*	Tangent	M

M	Sine	*Co-sine*	Tangent	*Co-tang.*	
30	9.544325	9.971588	9.572738	10.427262	30
31	9.544663	9.971540	9.573123	10.426877	29
32	9.545000	9.971493	9.573507	10.426492	28
33	9.545338	9.971446	9.573892	10.426108	27
34	9.545674	9.971398	9.574276	10.425724	26
35	9.546011	9.971351	9.574660	10.425340	25
36	9.546347	9.971303	9.575044	10.424956	24
37	9.546683	9.971256	9.575427	10.424573	23
38	9.547019	9.971208	9.575810	10.424189	22
39	9.547354	9.971161	9.576193	10.423807	21
40	9.547689	9.971112	9.576576	10.423424	20
41	9.548024	9.971065	9.576958	10.423041	19
42	9.548358	9.971018	9.577341	10.422659	18
43	9.548693	9.970970	9.577723	10.422277	17
44	9.549026	9.970922	9.578104	10.421896	16
45	9.549360	9.970874	9.578486	10.421514	15
46	9.549693	9.970826	9.578867	10.421133	14
47	9.550026	9.970779	9.579248	10.420752	13
48	9.550359	9.970731	9.579628	10.420371	12
49	9.550692	9.970683	9.580009	10.419991	11
50	9.551024	9.970634	9.580389	10.419611	10
51	9.551355	9.970586	9.580769	10.419231	9
52	9.551687	9.970538	9.581149	10.418851	8
53	9.552018	9.970490	9.581528	10.418472	7
54	9.552349	9.970442	9.581907	10.418092	6
55	9.552680	9.970394	9.582286	10.417713	5
56	9.553010	9.970345	9.582665	10.417335	4
57	9.553340	9.970297	9.583043	10.416956	3
58	9.553670	9.970249	9.583422	10.416578	2
59	9.554000	9.970200	9.583800	10.416200	1
60	9.554329	9.970152	9.584177	10.415823	0
	Co-sine	Sine	*Co-tang.*	Tangent	M

M	Sine	Co-sine	Tangent	Co-tang.	
0	9.554329	9.970152	9.584177	10.415822	60
1	9.554658	9.970103	9.584555	10.415445	59
2	9.554987	9.970055	9.584932	10.415068	58
3	9.555315	9.970006	9.585308	10.414691	57
4	9.555643	9.969957	9.585686	10.414314	56
5	9.555971	9.969909	9.586062	10.413938	55
6	9.556299	9.969860	9.586439	10.413561	54
7	9.556626	9.969811	9.586815	10.413185	53
8	9.556953	9.969762	9.587190	10.412800	52
9	9.557279	9.969713	9.587566	10.412434	51
10	9.557606	9.969665	9.587941	10.412059	50
11	9.557932	9.969616	9.588316	10.411684	49
12	9.558258	9.969567	9.588691	10.411309	48
13	9.558583	9.969518	9.589066	10.410934	47
14	9.558909	9.969469	9.589440	10.410560	46
15	9.559234	9.969419	9.589814	10.410185	45
16	9.559558	9.969370	9.590188	10.409812	44
17	9.559883	9.969321	9.590561	10.409438	43
18	9.560207	9.969272	9.590935	10.409065	42
19	9.560531	9.969223	9.591308	10.408692	41
20	9.560855	9.969173	9.591681	10.408319	40
21	9.561178	9.969124	9.592054	10.407946	39
22	9.561501	9.969075	9.592426	10.407574	38
23	9.561824	9.969025	9.592798	10.407201	37
24	9.562146	9.968976	9.593170	10.406829	36
25	9.562468	9.968926	9.593542	10.406457	35
26	9.562790	9.968877	9.593914	10.406086	34
27	9.563112	9.968827	9.594285	10.405715	33
28	9.563433	9.968777	9.594656	10.405344	32
29	9.563754	9.968728	9.595027	10.405073	31
30	9.564075	9.968678	9.595397	10.404602	30
	Co-sine	Sine	Co-tang.	Tangent	M

Degree 68.

M	Sine	Co-sine	Tangent	Co-tang.	
30	9.564075	9.968678	9.595397	10.404602	30
31	9.564396	9.968628	9.595768	10.404232	29
32	9.564716	9.968578	9.596138	10.403862	28
33	9.565036	9.968528	9.596508	10.403492	27
34	9.565356	9.968478	9.596878	10.403122	26
35	9.565675	6.968428	9.597247	10.402753	25
36	9.565995	9.968378	9.597616	10.402384	24
37	9.566314	9.968328	9.597985	10.402015	23
38	9.566632	9.968278	9.598354	10.401646	22
39	9.566951	9.968228	9.598722	10.401277	21
40	9.567269	9.968178	9.599091	10.400909	20
41	9.567587	9.968128	9.599459	10.400541	19
42	9.567904	9.968078	9.599827	10.400173	18
43	9.568222	9.968027	9.600194	10.399806	17
44	9.568539	9.967977	9.600562	10.399438	16
45	9.568855	9.967927	9.600929	10.399071	15
46	9.569172	9.967876	9.601296	10.398704	14
47	9.569488	9.967826	9.601662	10.398337	13
48	9.569804	9 967775	9.602029	10.397971	12
49	9.570120	9.967725	9.602395	10.397605	11
50	9.570435	9.967674	9.602761	10.397239	10
51	9.570751	9.967623	9.603127	10.396873	9
52	9.571065	9.967573	9.603493	10.396507	8
53	9.571380	9.967522	9.603858	10.396142	7
54	9.571695	9.967471	9.604223	10.395777	6
55	9.572009	9.967420	9.604588	10.395412	5
56	9.572322	9.967370	9.604953	10.395047	4
57	9.572636	9.967319	9.605317	10.394683	3
58	9.572949	9.967268	9.605681	10.394318	2
59	9.573263	9.967217	9.606046	10.393954	1
60	9.573575	9.967166	9.606409	10.393590	0
	Co-sine	Sine	Co-tang.	Tangent	M

M	Sine	Co-sine		Tangent	Co-tang.	
0	9.573575	9.967166		9.606409	10.393590	60
1	9.573888	9.967115		9.606773	10.393227	59
2	9.574200	9.967064		9.607136	10.392863	58
3	9.574512	9.957012		9.607500	10.392500	57
4	9.574824	9.966961		9.607862	10.392137	56
5	9.575135	9.966910		9.608225	10.391774	55
6	9.575447	9.966859		9.608588	10.391412	54
7	9.575758	9.966807		9.608950	10.391050	53
8	9.576068	9.966756		9.609312	10.390688	52
9	9.576379	9.966705		9.609674	10.390326	51
10	9.576689	9.966653		9.600036	10.389964	50
11	9.576999	9.966602		9.610397	10.389603	49
12	9.577309	9.966550		9.610758	10.389241	48
13	9.577618	9.966499		9.611119	10.388880	47
14	9.577927	9.966447		9.611480	10.388520	46
15	9.578236	9.966395		9.611841	10.388159	45
16	9.578545	9.966344		9.612201	10.387799	44
17	9.578853	9.966292		9.612561	10.387438	43
18	9.579161	9.966240		9.612921	10.387078	42
19	9.579469	9.966188		9.613281	10.386719	41
20	9.579777	9.966136		9.613641	10.386359	40
21	9.580084	9.966084		9.614000	10.386000	39
22	9.580392	9.966032		9.614359	10.385641	38
23	9.580698	9.965980		9.614718	10.385282	37
24	9.581005	9.965928		9.615077	10.384923	36
25	9.581311	9.965876		9.615435	10.384565	35
26	9.581618	9.965824		9.615793	10.384207	34
27	9.581923	9.965772		9.616151	10.383448	33
28	9.582229	9.965720		9.616509	10.383491	32
29	9.582534	9.965668		9.616867	10.383133	31
30	9.582840	9.965615		9.617224	10.382776	30
	Co-sine	Sine		Co-tang.	Tangent	M

M	Sine	Co-sine	Tangent	Co-tang.	
30	9.582840	9.965615	9.617224	10.382776	30
31	9.583144	9.965563	9.617581	10.382418	29
32	9.583449	9.965511	9.617938	10.382061	28
33	9.583753	9.965458	9.618295	10.381705	27
34	9.584058	9.965406	9.618652	10.381348	26
35	9.584361	9.965353	9.619008	10.380992	25
36	9.584665	9.965301	9.619364	10.380635	24
37	9.584968	9.965248	9.619720	10.380279	23
38	9.585271	9.965195	9.620076	10.379924	22
39	9.585574	9.965143	9.620432	10.379568	21
40	9.585877	9.965090	9.620787	10.379213	20
41	9.586179	9.965037	9.621142	10.378858	19
42	9.586481	9.964984	9.621497	10.378503	18
43	9.586783	9.964931	9.621852	10.378148	17
44	9.587085	9.964878	9.622206	10.377793	16
45	9.587386	9.964825	9.622561	10.377439	15
46	9.587687	9.964772	9.622915	10.377085	14
47	9.587988	9.964719	9.623269	10.376731	13
48	9.588289	9.964666	9.623623	10.376377	12
49	9.588589	9.964613	9.623976	10.376024	11
50	9.588890	9.964560	9.624330	10.375670	10
51	9.589190	9.964507	9.624683	10.375317	9
52	9.589489	9.964454	9.625036	10.374964	8
53	9.589789	9.964400	9.625388	10.374612	7
54	9.590088	9.964347	9.625741	10.374259	6
55	9.590387	9.964294	9.626093	10.373907	5
56	9.590686	9.964240	9.626445	10.373555	4
57	9.590984	9.964187	9.626797	10.373203	3
58	9.591282	9.964133	9.627149	10.372850	2
59	9.591580	9.964080	9.627501	10.372499	1
60	9.591878	9.964026	9.627852	10.372148	0
	Co-sine	Sine	Co-tang.	Tangent	M

Degree 67.

M	Sine	*Co-sine*	Tangent	*Co-tang.*	
0	9.591878	9.964026	9.627852	10.372148	60
1	9.592175	9.963972	9.628203	10.371797	59
2	9.592473	9.963919	9.628554	10.371446	58
3	9.592770	9.963865	9.628905	10.371095	57
4	9.593067	9.963811	9.629255	10.370744	56
5	9.593363	9.963757	9.629606	10.370394	55
6	9.593659	9.963703	9.629956	10.370044	54
7	9.593955	9.963650	9.630306	10.369694	53
8	9.594251	9.963596	9.630655	10.369344	52
9	9.594547	9.963542	9.631005	10.368995	51
10	9.594842	9.963488	9.631354	10.368645	50
11	9.595137	9.963433	9.631704	10.368296	49
12	9.595432	9.963379	9.632053	10.367947	48
13	9.595727	9.963325	9.632401	10.367598	47
14	9.596021	9.963271	9.632750	10.367250	46
15	9.596315	9.963217	9.633098	10.366901	45
16	9.596610	9.963102	9.633447	10.366553	44
17	9.596903	9.963108	9.633795	10.366205	43
18	9.597196	9.963054	9.634143	10.365857	42
19	9.597490	9.962999	9.634490	10.365510	41
20	9.597783	9.962945	9.634838	10.365162	40
21	9.598075	9.962892	9.635185	10.364815	39
22	9.598368	9.962836	9.635530	10.364468	38
23	9.598660	9.962781	9.635879	10.364121	37
24	9.598952	9.962726	9.636226	10.363774	36
25	9.599244	9.962672	9.636571	10.363428	35
26	9.599536	9.962617	9.636918	10.363081	34
27	9.599827	9.962562	9.637205	10.362735	33
28	9.600118	9.962507	9.637610	10.362389	32
29	9.600409	9.962453	9.637956	10.362044	31
30	9.600700	9.962398	9.638302	10.361698	30
	Co-sine	Sine	*Co-tang.*	Tangent	M

Degree 66.

M	Sine	Co-sine	Tangent	Co-tang.	
30	9.600700	9.967398	9.638302	10.361698	30
31	9.600990	9.962343	9.638647	10.361353	29
32	9.601280	9.962288	9.638992	10.361007	28
33	9.601570	9.962233	9.639337	10.360662	27
34	9.601860	9.962178	9.639682	10.360318	26
35	9.602149	9.962122	9.640027	10.359973	25
36	9.602439	9.962067	9.640371	10.359629	24
37	9.602728	9.962012	9.640716	10.359284	23
38	9.603017	9.961957	9.641060	10.358940	22
39	9.603305	9.961902	9.641404	10.358596	21
40	9.603594	9.961846	9.641747	10.358253	20
41	9.603882	9.961791	9.642091	10.357909	19
42	9.604170	9.961735	9.642434	10.357566	18
43	9.604457	9.961680	9.642777	10.357223	17
44	9.604745	9.961624	9.643120	10.356980	16
45	9.605032	9.961569	9.643463	10.356537	15
46	9.605319	9.961513	9.643806	10.356194	14
47	9.605606	9.961458	9.644148	10.355852	13
48	9.605892	9.961402	9.644490	10.355510	12
49	9.606179	9.961346	9.644832	10.355168	11
50	9.606465	9.961290	9.645174	10.354826	10
51	9.606750	9.961235	9.645516	10.354484	9
52	9.607[illegible]6	9.961179	9.645857	10.354142	8
53	9.60[illegible]22	9.961123	9.646199	10.353801	7
54	9.607607	9.961067	9.646540	10.353460	6
55	9.607892	9.961011	9.646881	10.353119	5
56	9.608176	9.960955	9.647222	10.352778	4
57	9.608461	9.960899	9.647562	10.352438	3
58	9.608745	9.960842	9.647903	10.352097	2
59	9.609029	9.960786	9.648243	10.351757	1
60	9.609313	9.960730	9.648583	10.351417	0
	Co-sine	Sine	Co-tang.	Tangent	M

Degree 66.

M	Sine	*Co-ſine*	Tangent	*Co-tang.*	
0	9.609313	9.960730	9.648583	10.351417	60
1	9.609597	9.960674	9.648923	10.351077	59
2	9.609880	9.960617	9.649263	10.350737	58
3	9.610163	9.960561	9.649602	10.350398	57
4	9.610446	9.960505	9.649942	10.350058	56
5	9.610729	9.960448	9.650281	10.349319	55
6	9.611012	9.960392	9.650620	10.349380	54
7	9.611294	9.960335	9.650959	10.349041	53
8	9.611576	9.960279	9.651297	10.348703	52
9	9.611858	9.960222	9.651636	10.348364	51
10	9.612140	9.960165	9.651974	10.348026	50
11	9.612421	9.960109	9.652312	10.347688	49
12	9.612702	9.960052	9.652650	10.347350	48
13	9.612983	9.959995	9.652988	10.347012	47
14	9.613264	9.959938	9.653326	10.346674	46
15	9.613545	9.959881	9.653663	10.346337	45
16	9.613825	9.959824	9.654000	10.345999	44
17	9.614105	9.959768	9.654337	10.345662	43
18	9.614385	9.959710	9.654674	10.345325	42
19	9.614665	9.959653	9.655011	10.344989	41
20	9.614944	9.959596	9.655348	10.344652	40
21	9.615223	9.959539	9.655684	10.344316	39
22	9.615502	9.959482	9.656020	10.343980	38
23	9.615781	9.959425	9.656356	1[illegible]43643	37
24	9.616060	9.959367	9.656692	10[illegible]3308	36
25	9.616338	9.959310	9.657028	10.342972	35
26	9.616616	9.959253	9.657363	10.342636	34
27	9.616894	9.959195	9.657699	10.342301	33
28	9.617172	9.959138	9.658034	10.341966	32
29	9.617450	9.959080	9.658369	10.341531	31
30	9.617727	9.959023	9.658704	10.341296	30
	Co-ſine	Sine	*Co-tang.*	Tangent	M

M	Sine	Co-sine	Tangent	Co-tang.	
30	9.617727	9.959023	9.658704	10.341296	30
31	9.618004	9.958965	9.659039	10.340926	29
32	9.618281	9.958908	9.659373	10.340627	28
33	9.618558	9.958850	9.659708	10.340292	27
34	9.618834	9.958792	9.660042	10.339958	26
35	9.619110	9.958734	9.660376	10.339624	25
36	9.619386	9.958677	9.660710	10.339290	24
37	9.619662	9.958619	9.661043	10.338957	23
38	9.619938	9.958561	9.661377	10.338623	22
39	9.620213	9.958503	9.661710	10.338290	21
40	9.620488	9.958445	9.662043	10.337956	20
41	9.620763	9.958387	9.662376	10.337623	19
42	9.621038	9.958329	9.662709	10.337291	18
43	9.621313	9.958271	9.663042	10.336958	17
44	9.621587	9.958212	9.663374	10.336625	16
45	9.621861	9.958154	9.663707	10.336293	15
46	9.622135	9.958096	9.664039	10.335961	14
47	9.622409	9.958038	9.664371	10.335629	13
48	9.622682	9.957979	9.664703	10.335297	12
49	9.622956	9.957921	9.665035	10.334965	11
50	9.623229	9.957862	9.665366	10.334634	10
51	9.623502	9.957804	9.665697	10.334302	9
52	9.623774	9.957745	9.666029	10.333971	8
53	9.624047	9.957687	9.666360	10.333640	7
54	9.624319	9.957628	9.666691	10.333309	6
55	9.624591	9.957570	9.667021	10.332979	5
56	9.624863	9.957511	9.667352	10.332648	4
57	9.625134	9.957452	9.667682	10.332318	3
58	9.625406	9.957393	9.668012	10.331987	2
59	9.625677	9.957334	9.668343	10.331657	1
60	9.625948	9.957276	9.668672	10.331327	0
	Co-sine	Sine	Co-tang.	Tangent	M

Degree 65.

M	Sine	Co-sine	Tangent	Co-tang.	
0	9.625948	9.957276	9.668672	10.331327	60
1	9.626219	9.957217	9.669002	10.330998	59
2	9.626490	9.957158	9.669332	10.330668	58
3	9.626760	9.957099	9.669661	10.330339	57
4	9.627030	9.957040	9.699990	10.330009	56
5	9.627300	9.956981	9.670320	10.329680	55
6	9.627570	9.956922	9.670649	10.329351	54
7	9.627840	9.956862	9.670977	10.329022	53
8	9.628109	9.956803	9.671306	10.328694	52
9	9.628378	9.956744	9.671634	10.328365	51
10	9.628647	9.956684	9.671963	10.328037	50
11	9.628916	9.956625	9.672291	10.327709	49
12	9.629184	9.956565	9.672619	10.327381	48
13	9.629453	9.956208	9.672947	10.327053	47
14	9.629721	9.956446	9.673274	10.326725	46
15	9.629989	9.956387	9.673603	10.326398	45
16	9.630257	9.956327	9.673929	10.326070	44
17	9.630524	9.956267	9.674256	10.325743	43
18	9.630792	9.956208	9.674584	10.325416	42
19	9.631059	9.956148	9.674910	10.325089	41
20	9.631326	6.956088	9.675237	10.324763	40
21	9.631592	9.956029	9.675564	10.324436	39
22	9.631859	9.955969	9.675890	10.324110	38
23	9.632125	9.955909	9.676216	10.323783	37
24	9.632392	9.955849	9.676543	10.323457	36
25	9.632657	9.955789	9.676869	10.323131	35
26	9.632923	9.955739	9.677194	10.322805	34
27	9.633189	9.955669	9.677520	10.322480	33
28	9.633454	9.955609	9.677845	10.322154	32
29	9.633719	9.955548	9.678171	10.321829	31
30	9.633984	9.955488	9.678496	10.321504	30
	Co-sine	Sine	Co-tang.	Tangent	M

M	Sine	Co-sine		Tangent	Co-tang.	
30	9.633984	9.955488		9.678496	10.321504	30
31	9.634249	9.955428		9.678821	10.321179	29
32	9.634514	9.955367		9.679146	10.320854	28
33	9.634778	9.955307		9.679471	10.320529	27
34	9.635042	9.955246		9.679795	10.320205	26
35	9.635306	9.955186		9.680120	10.319880	25
36	9.635570	9.955125		9.680444	10.319556	24
37	9.635833	9.955065		9.680768	10.319232	23
38	9.636097	9.955004		9.681092	10.318908	22
39	9.636360	9.954944		9.681416	10.318584	21
40	9.636623	9.954883		9.681740	10.318260	20
41	9.636886	9.954823		9.682063	10.317937	19
42	9.637148	9.954762		9.682386	10.317613	18
43	9.637411	9.954701		9.682710	10.317290	17
44	9.637673	9.954640		9.683033	10.316967	16
45	9.637935	9.954579		9.683356	10.316644	15
46	9.638197	9.954518		9.683678	10.316321	14
47	9.638458	9.954457		9.684001	10.315999	13
48	9.638720	9.954396		9.684324	10.315676	12
49	9.638981	9.954335		9.684646	10.315354	11
50	9.639242	9.954274		9.684968	10.315032	10
51	9.639503	9.954213		9.685290	10.314710	9
52	9.639764	9.954152		9.685612	10.313388	8
53	9.640024	9.954090		9.685934	10.314066	7
54	9.640284	9.954029		9.686255	10.313745	6
55	9.640544	9.954968		9.686577	10.313423	5
56	9.640804	9.953906		9.686898	10.313102	4
57	9.641064	9.953845		9.687219	10.312781	3
58	9.641323	9.953783		9.687540	10.312460	2
59	9.641583	9.953722		9.687861	10.312 38	1
60	9.641842	9.953660		9.688182	10.311818	0
	Co-sine	Sine		Co-tang.	Tangent	M

Degree 64.

M	Sine	Co-sine	Tangent	Co-tang.	
0	9.641842	9.953660	9.688182	10.311818	60
1	9.642101	9.953598	9.688502	10.311498	59
2	9.642360	9.953537	9.688823	10.311177	58
3	9.642618	9.953475	9.689143	10.310857	57
4	9.642876	9.953413	9.689463	10.310537	56
5	9.643135	9.953351	9.689783	10.310237	55
6	9.643393	9.953290	9.690103	10.309897	54
7	9.643650	9.953228	9.690423	10.309577	53
8	9.643908	9.953166	9.690742	10.309258	52
9	9.644165	9.953104	9.691063	10.308938	51
10	9.644423	9.953042	9.691381	10.308619	50
11	9.644680	9.952980	9.691700	10.308300	49
12	9.644936	9.952917	9.692019	10.307981	48
13	9.645193	9.952855	9.692338	10.307662	47
14	9.645449	9.952793	9.692656	10.307343	46
15	9.645706	9.952731	9.692975	10.307025	45
16	9.645962	9.952668	9.693293	10.306706	44
17	9.646218	9.952606	9.693612	10.306388	43
18	9.646473	9.952544	9.693930	10.306070	42
19	9.646729	9.952481	9.694248	10.305752	41
20	9.646984	9.952419	9.694566	10.305434	40
21	9.647239	9.952356	9.694883	10.305117	39
22	9.647494	9.952294	9.695201	10.304799	38
23	9.647749	9.952231	9.695518	10.304482	37
24	9.648004	9.952168	9.695835	10.304164	36
25	9.648258	9.952105	9.696153	10.303847	35
26	9.648512	9.952043	9.696470	10.303530	34
27	9.648766	9.951980	9.696786	10.303213	33
28	9.648020	9.951917	9.697103	10.302897	32
29	9.649274	9.951854	9.697420	10.302580	31
30	9.649527	9.051791	9.697738	10.302264	30
	Co-sine	Sine	Co-tang.	Tangent	M

M	Sine	*Co-sine*		Tangent	*Co-tang.*	
30	9.649527	9.951791		9.697738	10.302264	30
31	9.649781	9.951728		9.698052	10.301947	29
32	9.650034	9.951665		9.698369	10.301631	28
33	9.650287	9.951602		9.698685	10.301315	27
34	9.650519	9.951539		9.699001	10.300999	26
35	9.650798	9.951476		9.699316	10.300684	25
36	9.651044	9.951412		9.699632	10.300368	24
37	9.651296	9.951349		9.699947	10.300052	23
38	9.651648	9.951286		9.700263	10.299737	22
39	9.651800	9.951222		9.700578	10.299422	21
40	9.652052	9.951159		9.700893	10.299107	20
41	9.652303	9.951095		9.701208	10.298792	19
42	9.652555	9.951032		9.701522	10.298477	18
43	9.652806	9.950968		9.701837	10.298163	17
44	9.653057	9.950905		9.702152	10.297848	16
45	9.653307	9.950841		9.702466	10.29[illegible]	15
46	9.653558	9.950777		9.702780	10.297219	14
47	9.653808	9.950714		9.703095	10.296905	13
48	9.654059	9.950650		9.703409	10.296591	12
49	9.654309	9.950586		9.703722	10.296277	11
50	9.654558	9.950522		9.704036	10.295964	10
51	9.654808	9.950458		9.704350	10.295656	9
52	9.655057	9.950394		9.704663	10.295337	8
53	9.655307	9.950330		9.704976	10.295023	7
54	9.655556	9.950266		9.705290	10.294710	6
55	9.655805	9.950202		9.705603	10.294397	5
56	9.656053	9.950138		9.705915	10.294084	4
57	9.656302	9.950074		9.706228	10.293771	3
58	9.656550	9.950009		9.706541	10.293459	2
59	9.656799	9.949945		9.706853	10.293146	1
60	9.656347	9.949881		9.707166	10.292834	0
	Co-sine	Sine		*Co-tang.*	Tangent	M

Degree 63.

M	Sine	Co-sine	Tangent	Co-tang.	
0	9.657047	9.949880	9.707166	10.292834	60
1	9.657295	9.949816	9.707478	10.292523	59
2	9.657542	9.949752	9.707790	10.292210	58
3	9.657790	9.949687	9.708102	10.291897	57
4	9.658037	9.949623	9.708414	10.291586	56
5	9.658284	9.949598	9.708726	10.291274	55
6	9.658531	9.949494	9.709037	10.290962	54
7	9.658777	9.949429	9.709349	10.290651	53
8	9.659024	9.949364	9.709660	10.290340	52
9	9.659271	9.949300	9.709971	10.290029	51
10	9.659517	9.949235	9.710282	10.289718	50
11	9.659763	9.949170	9.710593	10.289407	49
12	9.660009	9.949105	9.710904	10.289096	48
13	9.660255	9.949040	9.711214	10.288785	47
14	9.660500	9.948976	9.711525	10.288475	46
15	9.66[illegible]746	9.948910	9.711836	10.288164	45
16	9.6[illegible]91	9.948845	9.712146	10.287854	44
17	9.661036	9.948760	9.712456	10.287544	43
18	9.661481	9.948715	9.712766	10.287234	42
19	9.661726	9.948650	9.713076	10.286924	41
20	9.661970	9.948584	9.713386	10.286614	40
21	9.662214	9.948519	9.713695	10.286305	39
22	9.662459	9.948453	9.714005	10.285995	38
23	9.662702	9.948388	9.714314	10.285686	37
24	9.662947	9.948323	9.714624	10.285376	36
25	9.663190	9.948257	9.714933	10.285067	35
26	9.663433	9.948191	9.715241	10.284758	34
27	9.663677	9.948126	9.715550	10.284449	33
28	9.663920	9.948060	9.715859	10.284140	32
29	9.664163	9.947995	9.716168	10.283832	31
30	9.664406	9.947929	9.716477	10.283523	30
	Co-sine	Sine	Co-tang.	Tangent	M

M	Sine	Co-sine	Tangent	Co-tang.	
30	9.664406	9.947929	9.716477	10.283523	30
31	9.664648	9.947863	9.716785	10.283215	29
32	9.664891	9.947797	9.717093	10.282907	28
33	9.665133	9.947731	9.717401	10.282598	27
34	9.665375	9.947665	9.717709	10.282290	26
35	9.665617	9.947599	9.718017	10.281983	25
36	9.665858	9.947533	9.718325	10.281675	24
37	9.666100	9.947467	9.718633	10.281367	23
38	9.666341	9.947401	9.718940	10.281060	22
39	9.666583	9.947335	9.719248	10.280752	21
40	9.666824	9.947269	9.719555	10.280445	20
41	9.667065	9.947203	9.719862	10.280138	19
42	9.667305	9.947136	9.720169	10.279831	18
43	9.667546	9.947070	9.720476	10.279524	17
44	9.667786	9.947004	9.720783	10.279217	16
45	9.668026	9.946937	9.721089	10.278911	15
46	9.668266	9.946871	9.721395	10.278604	14
47	9.668506	9.946804	9.721702	10.278298	13
48	9.668746	9.946738	9.722008	10.277991	12
49	9.668986	9.946671	9.722315	10.277685	11
50	9.669225	9.946604	9.722621	10.277379	10
51	9.669464	9.946537	9.722927	10.277073	9
52	9.669703	9.946471	9.723232	10.276768	8
53	9.669942	9.946404	9.723538	10.276462	7
54	9.670181	9.946337	9.723843	10.276156	6
55	9.670419	9.946270	9.724149	10.275851	5
56	9.670657	9.946203	9.724454	10.275546	4
57	9.670896	9.946136	9.724759	10.275240	3
58	9.671134	9.946069	9.725065	10.274935	2
59	9.671372	9.946002	9.725369	10.274630	1
60	9.671609	9.945935	9.725674	10.274326	0
	Co-sine.	Sine	Co-tang.	Tangent	M

M	Sine	Co-sine	Tangent	Co-tang.	
0	9.671609	9.945935	9.725674	10.274326	60
1	9.671847	9.945868	9.725979	10.274021	59
2	9.672084	9.945800	9.726284	10.273816	58
3	9.672321	9.945733	9.726588	10.273412	57
4	9.672558	9.945666	9.726892	10.273107	56
5	9.672795	9.945598	9.727197	10.272803	55
6	9.673032	9.945531	9.727501	10.272499	54
7	9.673268	9.945463	9.727805	10.272195	53
8	9.673505	9.945396	9.728109	10.271891	52
9	9.673741	9.945328	9.728412	10.271587	51
10	9.673977	9.945261	9.728716	10.271284	50
11	9.674213	9.945193	9.729020	10.270980	49
12	9.674448	9.945125	9.729323	10.270677	48
13	9.674684	9.945058	9.729626	10.270374	47
14	9.674919	9.944990	9.729929	10.270070	46
15	9.675154	9.944922	9.730232	10.269767	45
16	9.675389	9.944854	9.730535	10.269464	44
17	9.675623	9.944786	9.730838	10.269162	43
18	9.675859	9.944718	9.731141	10.268859	42
19	9.676094	9.944650	9.731443	10.268559	41
20	9.676328	9.944582	9.731746	10.268254	40
21	9.676562	9.944514	9.732048	10.267952	39
22	9.676796	9.944446	9.732351	10.267649	38
23	9.677030	9.944377	9.732653	10.267347	37
24	9.677264	9.944309	9.732955	10.267045	36
25	9.677497	9.944241	9.733257	10.266743	35
26	9.677731	9.944172	9.733558	10.266441	34
27	9.677964	9.944104	9.733860	10.266140	33
28	9.678197	9.944016	9.734162	10.265838	32
29	9.678430	9.943967	9.734463	10.265537	31
30	9.678663	9.943898	9.734764	10.265236	30
	Co-sine.	Sine	Co-tang.	Tangent	M

M	Sine	Co-sine	Tangent	Co-tang.	
30	9.678663	9.943898	9.734764	10.265236	30
31	9.678895	9.943830	9.735666	10.264934	29
32	9.679128	9.943761	9.735362	10.264633	20
33	9.670360	9.943692	9.735668	10.264332	27
34	9.679592	9.943624	9.735968	10.264031	26
35	9.679824	9.943555	9.736269	10.263731	25
36	9.680056	9.943486	9.736570	10.263430	24
37	9.680288	9.943417	9.736870	10.263130	23
38	9.680519	9.943348	9.737171	10.262829	22
59	9.680750	9.943279	9.737471	10.262529	21
40	9.680982	9.943210	9.737771	10.262229	20
41	9.681213	9.943141	9.738071	10.261929	19
42	9.681443	9.943072	9.738371	10.261629	18
43	9.681674	9.943003	9.738671	10.261329	17
44	9.681904	9.942933	9.738971	10.261029	16
45	9.682135	9.942864	9.739271	10.260729	15
46	9.682365	9.942795	9.739570	10.260430	14
47	9.682595	9.942725	9.739870	10.260130	13
48	9.682825	9.942656	9.740169	10.259831	12
49	9.683055	9.942587	9.740468	10.259532	11
50	9.683284	9.942517	9.740767	10.259233	10
51	9.683514	9.942448	9.741066	10.258934	9
52	9.683743	9.942378	9.741365	10.258635	8
53	9.683972	9.942308	9.741664	10.258336	7
54	9.684201	9.942239	9.741962	10.258038	6
55	9.684430	9.942169	9.742261	10.257739	5
56	9.684658	9.942099	9.742559	10.257441	4
57	9.684887	9.942029	9.742858	10.257142	3
58	9.685115	9.941959	9.743156	10.256844	2
59	9.685343	9.941889	9.743454	10.256546	1
60	9.685571	9.941819	9.743751	10.256248	0
M	Co-sine	Sine	Co-tang.	Tangent	M

M	Sine	Co-sine	Tangent	Co-tang.	
0	9.685571	9.941819	9.743752	10.256248	60
1	9.685799	9.941749	9.744050	10.255950	59
2	9.686027	9.941679	9.744348	10.255652	58
3	9.686254	9.941609	9.744645	10.255355	57
4	9.686482	9.941539	9.744943	10.255057	56
5	9.686709	9.941468	9.745240	10.254760	55
6	9.686936	9.941398	9.745538	10.254462	54
7	9.687163	9.941328	9.745835	10.254165	53
8	9.687389	9.941257	9.746132	10.253868	52
9	9.687616	9.941187	9.746429	10.253571	51
10	9.687842	9.941116	9.746726	10.253274	50
11	9.688069	9.941046	9.747023	10.252977	49
12	9.688295	9.940975	9.747319	10.252680	48
13	9.688523	9.940905	9.747616	10.252384	47
14	9.688747	9.940834	9.747912	10.252087	46
15	9.688972	9.940763	9.748209	10.251791	45
16	9.689198	9.940693	9.748505	10.251495	44
17	9.689421	9.940622	9.748801	10.251199	43
18	9.689648	7.940551	9.749097	10.250902	42
19	9.689873	9.940480	9.749393	10.250607	41
20	9.690098	9.940409	9 749689	10.250311	40
21	9.690323	9.940338	9.749985	10.250015	39
22	9.690548	9.940267	9.750281	10.249719	38
23	9.690772	9.940196	9.750576	10.249424	37
24	9.690996	9.940125	9.750872	10.249128	36
25	9.691220	9.940053	9.751167	10.248833	35
26	9.691444	9.939982	9.751462	10.248538	34
27	9.691668	9.939911	9.751757	10.248243	33
28	9.691892	9.939840	9.752052	10.247948	32
29	9.692115	9.939768	9.752347	10.247653	31
30	9.692339	9.939697	9.752642	10.247358	30
	Co-sine	Sine	Co-tang.	Tangent	M

Degree 60.

M	Sine	Co-*sine*	Tangent	Co-*tang.*	
30	9.692339	9.939697	9.752642	10.247358	30
31	9.692562	9.939625	9.752937	10.247063	29
32	9.692785	9.939554	9.753231	10.246769	28
33	9.693008	9.939482	9.753526	10.246474	27
34	9.693231	9.939410	9.753820	10.246180	26
35	9.693453	9.939339	9.754115	10.245885	25
36	9.693676	9.939267	9.754409	10.245591	24
37	9.693898	9.939195	9.754703	10.245297	23
38	9.694120	9.939123	9.754997	10.245003	22
39	9.694342	9.939051	9.755291	10.244709	21
40	9.694564	9.938980	9.755584	10.244415	20
41	9.694786	9.938908	9.755878	10.244122	19
42	9.695007	9.938835	9.756172	10.243828	18
43	9.695229	9.938763	9756465	10.243535	17
44	9.695450	9.938691	9.756759	10.243241	16
45	9.695671	9.938619	9.757052	10.242948	15
46	9.695892	9.938547	9.757345	10.242655	14
47	9.696113	9.938475	9.757638	10.242362	13
48	9.696334	9.938402	9.757931	10.242069	12
49	9.696554	9.938330	9.758224	10.241776	11
50	9.696774	9.938257	9.758517	10.241483	10
51	9.696995	9.938185	9.758810	10.241190	9
52	9.697215	9.938112	9.759102	10.240898	8
53	9.697435	9.938040	9.759395	10.240605	7
54	9.697654	9.937967	9.759687	10.240313	6
55	9.697874	9.937895	9.759979	10.240021	5
56	9.698093	9.937822	9.760271	10.239728	4
57	9.698313	9.937749	9.760564	10.239436	3
58	9.698532	9.937676	9.760856	10.239144	2
59	9.698751	9.937603	9.761147	10.238852	1
60	9.698970	9.937531	9.761439	10.238561	0
	Co-*sine*	Sine	Co-*tang.*	Tangent	M

Degree 60.

M	Sine	Co-sine	Tangent	Co-tang.	
0	9.698970	9.937531	9.761439	10.238561	60
1	9.699189	9.937458	9.761731	10.238269	59
2	9.699407	9.937385	9.762023	10.237977	58
3	9.699626	9.937312	9.762314	10.237686	57
4	9.699844	9.937238	9.762606	10.237394	56
5	9.700062	9.937165	9.762897	10.237103	55
6	7.700280	9.937092	9.763188	10.236812	54
7	9.700498	9.937019	9.763479	10.236521	53
8	9.700716	9.936945	9.763770	10.236230	52
9	9.700933	9.936872	9.764061	10.235939	51
10	9.701151	9.936799	9.764352	10.235648	50
11	9.701568	9.936725	9.764643	10.235357	49
12	9.701585	9.936652	9.764933	10.235067	48
13	9.701802	9.936578	9.765224	10.234776	47
14	9.702019	9.936505	9.765514	10.234486	46
15	9.702236	9.936431	9.765805	10.234195	45
16	9.702452	9.936357	9.766095	10.233905	44
17	9.702669	9.936284	9.766385	10.233615	43
18	9.702885	9.936210	9.766675	10.233325	42
19	9.703101	9.936136	9.766965	10.233035	41
20	9.703317	9.936062	9.767255	10.232745	40
21	9.703533	9.935988	9.767545	10.232455	39
22	9.703748	9.935914	9.767834	10.232166	38
23	9.703964	9.935840	9.768124	10.231876	37
24	9.704179	9.935766	9.768413	10.231587	36
25	9.704395	9.935692	9.768703	10.231297	35
26	9.704610	9.935618	9.768992	10.231008	34
27	9.704820	9.935543	9.769281	10.230719	33
28	9.705040	9.935469	9.769570	10.230430	32
29	9.705254	9.935395	9.769859	10.230141	31
30	9.705469	9.935320	9.770148	10.229852	30
	Co-sine	Sine	Co-tang.	Tangent	M

M	Sine	Co-sine	Tangent	Co-tang.	
30	9.705469	9.935320	9.770148	10.229852	30
31	9.705683	9.935246	9.770437	10.229563	29
32	9.705897	9.935171	9.770726	10.229274	28
33	9.706112	9.935097	9.771015	10.228985	27
34	9.706327	9.935022	9.771303	10.228696	26
35	9.706539	9.934948	9.771592	10.228408	25
36	9.706753	9.934873	9.771880	10.228120	24
37	9.706967	9.934798	9.772168	10.227832	23
38	9.707180	9.934723	9.772456	10.227543	22
39	9.707393	9.934649	9.772745	10.227255	21
40	9.707606	9.934574	9.773033	10.226967	20
41	9.707819	9.934499	9.773321	10.226679	19
42	9.708032	9.934424	9.773608	10.226391	18
43	9.708245	9.934349	9.773896	10.226104	17
44	9.708457	9.934274	9.774184	10.225816	16
45	9.708670	9.934199	9.774471	10.225529	15
46	9.708882	9.934123	9.774759	10.225241	14
47	9.709094	9.934048	9.775046	10.224954	13
48	9.709306	9.933973	9.775333	10.224666	12
49	9.709518	9.933897	9.775621	10.224379	11
50	9.709730	9.933822	9.775908	10.224092	10
51	9.709941	9.933747	9.776195	10.223805	9
52	9.710153	9.933671	9.776482	10.223518	8
53	9.710364	9.933596	9.776768	10.223232	7
54	9.710575	9.933520	9.777055	10.222945	6
55	9.710786	9.933444	9.777342	10.222658	5
56	9.710997	9.933369	9.777628	10.222372	4
57	9.711208	9.933293	9.777915	10.222085	3
58	9.711418	9.933217	9.778201	10.221799	2
59	9.711629	9.933141	9.778487	10.221513	1
60	9.711839	9.933066	9.778774	10.221226	0
	Co-sine	Sine	Co-tang.	Tangent	M

Degree 59.

M	Sine	Co-fine	Tangent	Co-tang.	
0	9.711839	9.933066	9.778774	10.221226	60
1	9.712049	9.932990	9.779060	10.220940	59
2	9.712259	9.932914	9.779346	10.220654	58
3	9.712469	9.932838	9.779632	10.220368	57
4	9.712679	9.932761	9.779918	10.220082	56
5	9.712889	9.932685	9.780203	10.219796	55
6	9.713098	9.932609	9.780489	10.219511	54
7	9.713308	9.932533	9.780775	10.219225	53
8	9.713517	9.932457	9.781060	10.218940	52
9	9.713726	9.932380	9.781346	10.218654	51
10	9.713935	9.932304	9.781631	10.218369	50
11	9.714144	9.932227	9.781916	10.218084	49
12	9.714352	9.932151	9.782202	10.217799	48
13	9.714561	9.932074	9.782480	10.217514	47
14	9.714769	9.931998	9.782771	10.217229	46
15	9.714977	9.931921	9.783056	10.216944	45
16	9.715186	9.931845	9.783341	10.216659	44
17	9.715394	9.931768	9.783626	10.216374	43
18	9.715601	9.931691	9.783910	10.216090	42
19	9.715809	9.931614	9.784195	10.215805	41
20	9.716017	9.931537	9.784479	10.215520	40
21	9.716224	9.931460	9.784764	10.215236	39
22	9.716431	9.931383	9.785048	10.214952	38
23	9.716639	9.931306	9.785332	10.214668	37
24	9.716846	9.931229	9.785616	10.214384	36
25	9.717053	9.931152	9.785900	10.214099	35
26	9.717259	9.931075	9.786184	10.213816	34
27	9.717466	9.930998	9.786468	10.213532	33
28	9.717672	9.930920	9.786752	10.213248	32
29	9.717879	9.930843	9.787036	10.212964	31
30	9.718085	9.930766	9.787319	10.212681	30
	Co-fine	Sine	Co-tang.	Tangent	M

Degree 58.

M	Sine	Co-sine	Tangent	Co-tang.	
30	9.718085	9.930766	9.787319	10.212681	30
31	9.718291	9.930688	9.787603	10.212397	29
32	9.718497	9.930611	9.787886	10.212114	28
33	9.718703	9.930533	9.788170	10.211830	27
34	9.718909	9.930456	9.788453	10.211547	26
35	9.719114	9.930378	9.788736	10.211264	25
36	9.719320	9.930300	9.789019	10.210981	24
37	9.719525	9.930223	9.789302	10.210698	23
38	9.719730	9.930145	9.789585	10.210415	22
39	9.719935	9.930067	9.789868	10.210132	21
40	9.720140	9.929989	9.790151	10.209849	20
41	9.720345	9.929911	9.790433	10.209566	19
42	9.720549	9.929833	9.790716	10.209284	18
43	9.720754	9.929755	9.790999	10.209001	17
44	9.720958	9.929677	9.790281	10.208719	16
45	9.721162	9.929599	9.791563	10.208436	15
46	9.721366	9.929521	9.791846	10.208154	14
47	9.721570	9.929442	9.792128	10.207872	13
48	9.721774	9.929364	9.792410	10.207590	12
49	9.721978	9.929286	9.792692	10.207308	11
50	9.722181	9.929207	9.792974	10.207024	10
51	9.722385	9.929129	9.793256	10.206744	9
52	9.722588	9.929050	9.793538	10.206462	8
53	9.722791	9.928972	9.793819	10.206180	7
54	9.722994	9.928893	9.794101	10.205899	6
55	9.723197	9.928814	9.794383	10.205617	5
56	9.723400	9.928736	9.794664	10.205336	4
57	9.723603	9.928657	9.794945	10.205054	3
58	9.723805	9.928578	9.795227	10.204773	2
59	9.724007	9.928499	9.795508	10.204492	1
60	9.724210	9.928420	9.795789	10.204211	0
	Co-sine	Sine	Co-tang.	Tangent	M

Degree 58.

M	Sine	*Co-sine*	Tangent	*Co-tang.*	
0	9.724210	9.928420	9.795789	10.204211	60
1	9.724412	9.928341	9.796070	10.203930	59
2	9.724614	9.928262	9.796351	10.203649	58
3	9.724816	9.928183	9.796632	10.203368	57
4	9.725017	9.928104	9.796913	10.203087	56
5	9.725219	9.928025	9.797194	10.202806	55
6	9.725420	9.927946	9.797474	10.202522	54
7	9.725622	9.921867	9.797755	10.202245	53
8	9.725823	9.927787	9.798036	10.201964	52
9	9.726024	9.927708	9.798316	10.201684	51
10	9.726225	9.927628	9.798596	10.201404	50
11	9.726426	9.927549	9.798877	10.201123	49
12	9.726626	9.927469	9.799157	10.200843	48
13	9.726827	9.927390	9.799437	10.200563	47
14	9.727027	9.927310	9.799717	10.200283	46
15	9.727228	9.927231	9.799997	10.200003	45
16	9.727428	9.927151	9.800277	10.199723	44
17	9.727628	9.927071	9.800557	10.199443	43
18	9.727828	9.926991	9.800836	10.199163	42
19	9.728027	9.926911	9.801116	10.198884	41
20	9.728227	9.926831	9.801396	10.198604	40
21	9.728427	9.926751	9.801675	10.198325	39
22	9.728626	9.926641	9.801955	10.198045	38
23	9.728825	9.926591	9.802234	10.197766	37
24	9.729024	9.926511	9.802513	10.197487	36
25	9.729223	9.926431	9.802792	10.197207	35
26	9.729422	9.926351	9.803072	10.196928	34
27	9.729621	9.926270	9.803351	10.196649	33
28	9.729820	9.926190	9.803630	10.196370	32
29	9.730018	9.926110	9.803908	10.196091	31
30	9.730216	9.926029	9.804187	10.195813	30
	Co-sine	Sine	*Co-tang.*	Tangent	M

Degree 57.

M	Sine	Co-sine	Tangent	Co-tang.	
30	9.730216	9.926029	9.804187	10.195813	30
31	9.730415	9.925949	9.804466	10.195534	29
32	9.730613	9.925868	9.804745	10.195255	28
33	9.730811	9.925787	9.805023	10.194977	27
34	9.731009	9.925707	9.805302	10.194698	26
35	9.731206	9.9.25626	9.805580	10.194420	25
36	9.731404	9.925545	9.805859	10.194141	24
37	9.731601	9.925464	9.806137	10.193863	23
38	9.731799	9.925384	9.806415	10.193585	22
39	9.731996	9.925303	9.80669[illegible]	10.193309	21
40	9.732193	9.925222	9.806971	10.193028	20
41	9.732390	9.925141	9.807249	10.192751	19
42	9.732587	9.925060	9.807527	10.192433	18
43	9.732784	9.924978	9.807805	10.192195	17
44	9.732980	9.924897	9.808083	10.191917	16
45	9.733177	9.924816	9.808361	10.191639	15
46	9.733373	9.924735	9.808638	10.191362	14
47	9.733569	9.924653	9.808916	10.191084	13
48	9.733765	9.924572	9.809193	10.190807	12
49	9.733961	9.924491	9.809471	10.190529	11
50	9.734157	9.924409	9.809748	10.190252	10
51	9.734353	9.924328	9.810025	10.189975	9
52	9.734548	9.924246	9.810302	10.189697	8
53	9.734744	9.924164	9.810580	10.189420	7
54	9.734939	9.924083	9.810857	10.189143	6
55	9.735134	9.924001	9.811134	10.188866	5
56	9.735330	9.923919	9.811410	10.188589	4
57	9.735525	9.923837	9.811687	10.188313	3
58	9.735719	9.923755	9.811964	10.188036	2
59	9.735914	9.923673	9.812241	10.187759	1
60	9.736109	9.923591	9.812517	10.187483	0
	Co-sine	Sine	Co-tang.	Tangent	M

Degree 57.

M	Sine	Co-sine	Tangent	Co-tang.	
0	9.736109	9.923591	9.812517	10.187483	60
1	9.736309	9.923509	9.812794	10.187206	59
2	9.736497	9.923427	9.813070	10.186930	58
3	9.736692	9.923345	9.813347	10.186653	57
4	9.736886	9.923263	9.813623	10.186377	56
5	9.737080	9.923180	9.813899	10.186101	55
6	9.737274	9.923098	9.814175	10.185824	54
7	9.737467	9.923016	9.814452	10.185548	53
8	9.737661	9.922933	9.814728	10.185272	52
9	9.737854	9.922851	9.815004	10.184996	51
10	9.7380[illegible]8	9.922768	9.815279	10.184720	50
11	9.738241	9.922686	9.815555	10.184445	49
12	9.738434	9.922603	9.815831	10.184169	48
13	9.738627	9.922520	9.816107	10.183893	47
14	9.738820	9.922438	9.816382	10.183617	46
15	9.739013	9.922355	9.816658	10.183342	45
16	9.739205	9.922272	9.816933	10.183066	44
17	9.739398	9.922189	9.817209	10.182791	43
18	9.739590	9.922106	9.817484	10.182516	42
19	9.739783	9.922023	9.817759	10.182240	41
20	9.739975	9.921940	9.818035	10.181965	40
21	9.740167	9.921857	9.818310	10.181690	39
22	9.740359	9.921774	9.818585	10.181415	38
23	9.740550	9.921691	9.818860	10.181140	37
24	9.740742	9.921607	9.819135	10.180865	36
25	9.740934	9.921524	9.819410	10.180590	35
26	9.741125	9.921441	9.819684	10.180315	34
27	9.741316	9.921357	9.819959	10.180041	33
28	9.741507	9.921274	9.820234	10.179766	32
29	9.741698	9.921190	9.820508	10.179492	31
30	9.741889	9.921107	9.820783	10.179217	30
	Co-sine	Sine	Co-tang.	Tangent	M

M	Sine	Co-sine	Tangent	Co-tang.	
30	9.741889	9.921107	9.820783	10.179217	30
31	9.742080	9.921023	9.821057	10.178943	29
32	9.742271	9.920939	9.821332	10.178668	28
33	9.742461	9.920855	9.821606	10.178394	27
34	9.742652	9.920772	9.821880	10.178120	26
35	9.742842	9.920688	9.822154	10.177846	25
36	9.743032	9.920604	9.822429	10.177571	24
37	9.743223	9.920520	9.822703	10.177297	23
38	9.743412	9.920436	9.822977	10.177023	22
39	9.743602	9.920352	9.823250	10.176739	21
40	9.743792	9.920268	9.823524	10.176476	20
41	9.743982	9.920184	9.823798	10.176202	19
42	9.744171	9.920099	9.824072	10.175928	18
43	9.744361	9.920015	9.824345	10.175655	17
44	9.744550	9.919931	9.824619	10.175381	16
45	9.744739	9.919846	9.824892	10.175108	15
46	9.744928	9.919762	9.825166	10.174834	14
47	9.745117	9.919677	9.825439	10.174560	13
48	9.745306	9.919593	9.825713	10.174287	12
49	9.745494	9.919508	9.825986	10.174014	11
50	9.745683	9.919424	9.826259	10.173741	10
51	9.745871	9.919339	9.826532	10.173468	9
52	9.746059	9.919254	9.826805	10.173195	8
53	9.746248	9.919169	9.827078	10.172922	7
54	9.746436	9.919084	9.827351	10.172649	6
55	9.746624	9.918999	9.827624	10.172376	5
56	9.746811	9.918915	9.827897	10.172103	4
57	9.746999	9.918830	9.828170	10.171830	3
58	9.747187	9.918744	9.828442	10.171558	2
59	9.747374	9.918659	9.828715	10.171285	1
60	9.747562	9.918574	9.828987	10.171012	0
	Co-sine	Sine	Co-tang.	Tangent	M

Degree 56.

M	Sine	*Co-sine*	Tangent	*Co-tang.*	
0	9.747562	9.918574	9.828987	10.171012	60
1	9.747749	9.918489	9.829260	10.170740	59
2	9.747936	9.918404	9.829532	10.170468	58
3	9.748123	9.918318	9.829805	10.170195	57
4	9.748319	9.918233	9.830077	10.169923	56
5	9.748497	9.918147	9.830349	10.169651	55
6	9.748683	9.918062	9.830621	10.169379	54
7	9.748870	9.917976	9.830891	10.166106	53
8	9.749056	9.917891	9.831165	10.168834	52
9	9.749242	9.917805	9.831437	10.168563	51
10	9.749429	9.917719	9.831709	10.168291	50
11	9.749615	9.917634	9.831981	10.168019	49
12	9.749801	9.917548	9.832253	10.167747	48
13	9.749986	9.917462	9.832525	10.167475	47
14	9.750172	9.917376	9.832796	10.167204	46
15	9.750358	9.917290	9.833068	10.166932	45
16	9.750543	9.917204	9.833339	10.166660	44
17	9.750729	9.917118	9.833621	10.166389	43
18	9.750914	9.917032	9.833882	10.166118	42
19	9.751099	9.916945	9.834154	10.165846	41
20	9.751284	9.916819	9.834425	10.165575	40
21	9.751469	9.916773	9.834696	10.165304	39
22	9.751654	9.916686	9.834967	10.165033	38
23	9.751838	9.916600	9.835238	10.164762	37
24	9.752023	9.916514	9.835509	10.164491	36
25	9.752207	9.916427	9.835780	10.164220	35
26	9.752392	9.916340	9.836051	10.163949	34
27	9.752576	9.916254	9.836322	10.163678	33
28	9.752760	9.916167	9.836593	10.163407	32
29	9.752944	9.916080	9.836864	10.163136	31
30	9.753128	9.915994	9.837134	10.162866	30
·	*Co-sine*	Sine	*Co-tang.*	Tangent	M

Degree 55.

M	Sine	Co-sine		Tangent	Co-tang.	
30	9.753128	9.915994		9.837134	10.162866	30
31	9.753312	9.915907		9.8374[illegible]	10.162595	29
32	9.753495	9.915820		9.837675	10.162325	28
33	9.753679	9.915733		9.837946	10.162054	27
34	9.753862	9.915646		9.838216	10.161784	26
35	9.754046	9.915559		9.838487	10.161513	25
36	9.754229	9.915472		9.838757	10.161243	24
37	9.754412	9.915385		9.839027	10.160973	23
38	9.754595	9.915297		9.839297	10.160702	22
39	9.754778	9.915210		9.839568	10.160432	21
40	9.754960	9.915123		9.839838	10.160162	20
41	9.755143	9.915035		9.840108	10.159892	19
42	9.755325	9.914948		9.840378	10.159622	18
43	9.755508	9.914860		9.840647	10.159352	17
44	9.755690	9.914773		9.840917	10.159083	16
45	9.755872	9.914685		9.841187	10.158813	15
46	9.756054	9.914597		9.841457	10.158543	14
47	9.756236	9.914510		9.841726	10.158273	13
48	9.756418	9.914422		9.841996	10.158004	12
49	9.756600	9.914334		9.842206	10.157734	11
50	9.756781	9.914146		9.842505	10.157465	10
51	9.756963	9.914158		9.842804	10.157195	9
52	9.757144	9.914070		9.843074	10.156926	8
53	9.757316	9.913982		9.843343	10.156657	7
54	9.757507	9.913894		9.843612	10.156387	6
55	9.757688	9.919806		9.843882	10.156118	5
56	9.757869	9.913718		9.844151	10.155849	4
57	9.758049	9.913630		9.844420	10.155580	3
58	9.758230	9.913541		9.844689	10.155311	2
59	9.758411	9.913453		9.844958	10.155041	1
60	9.758591	9.913361		9.845227	10.154773	0
M	Co-sine	Sine		Co-tang.	Tangent	M

M	Sine	*Co-sine*	Tangent	*Co-tang.*	
0	9.758591	9.913364	9.845227	10.154774	60
1	9.758772	9.913276	9.845496	10.154504	59
2	9.758952	9.913187	9.845764	10.154235	58
3	9.759132	9.913099	9.846033	10.153967	57
4	9.759312	9.913010	9.846302	10.153698	56
5	9.759492	9.912921	9.846570	10.153429	55
6	9.759672	9.912833	9.846839	10.153161	54
7	9.759851	9.912744	9.847107	10.152892	53
8	9.760031	9.912655	9.847376	10.152624	52
9	9.760210	9.912566	9.847644	10.152356	51
10	9.760390	9.912477	9.847913	10.152087	50
11	9.760569	9.912388	9.848181	10.151819	49
12	9.760748	9.912299	9.848449	10.151551	48
13	9.760927	9.912210	9.848717	10.151283	47
14	9.761106	9.912121	9.848985	10.151015	46
15	9.761285	9.912031	9.849254	10.150746	45
16	9.761464	9.911942	9.849522	10.150478	44
17	9.761642	9.911853	9.849789	10.150214	43
18	9.761821	9.911763	9.850057	10.149943	42
19	9.76199[illegible]	9.911674	9.850325	10.149675	41
20	9.762177	9.911584	9.850593	10.149407	40
21	9.762356	9.911495	9.850861	10.149139	39
22	9.762534	9.911405	9.851128	10.148872	38
23	9.762712	9.911315	9.851396	10.148604	37
24	9.762889	9.911226	9.851664	10.148336	36
25	9.763067	9.911136	9.851931	10.148069	35
26	9.763245	9.911046	9.852199	10.147801	34
27	9.763422	9.910956	9.852466	10.147534	33
28	9.763599	9.910866	9.852731	10.147267	32
29	9.763777	9.910776	9.853001	10.146999	31
30	9.763954	9 910686	9.853268	10.146732	30
	Co-sine	Sine	*Co-tang.*	Tangent	M

M	Sine	*Co-sine*	Tangent	*Co-tang.*	
30	9.763954	9.910686	9.853208	10.146732	30
31	9.764131	9.910596	9.853532	10.146465	29
32	9.764308	9.910506	9.853802	10.146198	28
33	9.764485	9.910415	9.854069	10.145930	27
34	9.764662	9.910325	9.854336	10.145664	26
35	9.764838	9.910235	9.854603	10.145397	25
36	9.765015	9.910144	9.854870	10.145130	24
37	9.765191	9.910054	9.855137	10.144863	23
38	9.765367	9.909963	9.855404	10.144596	22
39	9.765544	9.909873	9.855671	10.144329	21
40	9.765720	9.909782	9.855937	10.144063	20
41	9.765896	9.909691	9.856204	10.143796	19
42	9.766071	9.909601	9.856471	10.143529	18
43	9.766247	9.909510	9.856737	10.143263	17
44	9.766423	9.909419	9.857004	10.142996	16
45	9.766598	9.909328	9.857270	10.142730	15
46	9.766774	9.909237	9.857537	10.142463	14
47	9.766949	9.909146	9.857803	10.142197	13
48	9.767124	9.909055	9.858069	10.141931	12
49	9.767299	9.908964	9.858336	10.141664	11
50	9.767474	9.908873	9.858602	10.141398	10
51	9.767649	9.908781	9.858868	10.141132	9
52	9.767824	9.908690	9.859134	10.140866	8
53	9.767997	9.908599	9.859400	10.140600	7
54	9.768173	9.908507	9.859666	10.140334	6
55	9.768348	9.908416	9.859932	10.140068	5
56	9.768522	9.908324	9.860198	10.139802	4
57	9.768696	9.908233	9.860464	10.139536	3
58	9.768871	9.908141	9.860730	10.139270	2
59	9.769045	9.908049	9.860995	10.139065	1
60	9.769219	9.907958	9.861261	10.138739	0
	Co-sine	Sine	*Co-tang.*	Tangent	M

M	Sine	Co-sine		Tangent	Co-tang.	
0	9.769219	9.907958		9.861261	10.138739	60
1	9.769392	9.907866		9.861527	10.138473	59
2	9.769566	9.907774		9.861792	10.138208	58
3	9.769740	9.907682		9.862058	10.137942	57
4	9.769913	9.907590		9.862323	10.137677	56
5	9.770087	9.907498		9.862589	10.137411	55
6	9.770260	9.907406		9.862854	10.137146	54
7	9.770433	9.907314		9.863119	10.136880	53
8	9.770606	9.907221		9.863385	10.136615	52
9	9.770779	9.907129		9.863650	10.136350	51
10	9.770952	9.907037		9.863915	10.136085	50
11	9.771125	9.906945		9.864180	10.135820	49
12	9.771298	9.906852		9.864445	10.135554	48
13	9.771470	9.906760		9.864710	10.135289	47
14	9.771643	9.906667		9.864975	10.135024	46
15	9.771815	9.906574		9.865240	10.134759	45
16	9.771987	9.906482		9.865505	10.134495	44
17	9.772159	9.906389		9.865770	10.134230	43
18	9.772331	9.906296		9.866035	10.133965	42
19	9.772503	9.906203		9.866300	10.133700	41
20	9.772675	9.906111		9.866564	10.133436	40
21	9.772847	9.906018		9.866829	10.133171	39
22	9.773018	9.905925		9.867094	10.132906	38
23	9.773190	9.905832		9.867358	10.132642	37
24	9.773361	9.905738		9.867623	10.132377	36
25	9.773533	9.905645		9.867887	10.132113	35
26	9.773704	9.905552		9.868152	10.131848	34
27	9.773875	9.905459		9.868416	10.131584	33
28	9.774046	9.905365		9.868680	10.131320	32
29	9.774217	9.905272		9.868945	10.131055	31
30	9.774388	9.905179		9.869209	10.130791	30
	Co-sine	Sine		Co-tang.	Tangent	M

M	Sine	Co-sine		Tangent	Co-tang.	
30	9.774388	9.905179		9.869209	10.130791	30
31	9.774558	9.905085		9.864773	10.130527	29
32	9.774729	9.904992		9.867337	10.130263	28
33	9.774899	9.904898		9.870001	10.129999	27
34	9.775070	9.904804		9.870265	10.129735	26
35	9.775240	9.904711		9.870529	10.129471	25
36	9.775410	9.904617		9.870793	10.129207	24
37	9.775580	9.904523		9.871057	10.128943	23
38	9.775750	9.904429		9.871321	10.128679	22
39	9.775920	9.904335		9.871585	10.128415	21
40	9.776090	9.904241		9.871849	10.128151	20
41	9.776259	9.904147		9.872112	10.127888	19
42	9.776429	9.904053		9.872376	10.127624	18
43	9.776598	9.903959		9.872640	10.127360	17
44	9.776768	9.903864		9.872903	10.127097	16
45	9.776937	9.903770		9.873167	10.126833	15
46	9.777106	9.903676		9.873430	10.126570	14
47	9.777275	9.903581		9.873694	10.126306	13
48	9.777444	9.903486		9.873957	10.126043	12
49	9.777613	9.903392		9.874220	10.125780	11
50	9.777781	9.903298		9.874484	10.125516	10
51	9.777950	9.903203		9.874747	10.125253	9
52	9.778119	9.903108		9.875010	10.124990	8
53	9.778287	9.903013		9.875273	10.124727	7
54	9.778455	9.902919		9.875536	10.124464	6
55	9.778623	9.902824		9.875799	10.124201	5
56	9.778792	9.902729		9.876063	10.123937	4
57	9.778960	9.902634		9.876326	10.123674	3
58	9.779129	9.902539		9.876589	10.123411	2
59	9.779295	9.902444		9.876851	10.123149	1
60	9.779463	9.902349		9.877114	10.122886	0
	Co-sine	Sine		Co-tang.	Tangent	M

M	Sine	*Co-sine*	Tangent	*Co-tang.*	
0	9.779463	9.902349	9.877114	10.122885	60
1	9.779631	9.902253	9.877377	10.122623	59
2	9.779798	9.902158	9.877640	10.122360	58
3	9.779965	9.902063	9.877903	10.122097	57
4	9.780133	9.901967	9.878165	10.121834	56
5	9.780300	9.901872	9.878428	10.121572	55
6	9.780467	9.901776	9.878691	10.121309	54
7	9.780634	9.901681	9.878953	10.121047	53
8	9.780801	9.901585	9.879216	10.120784	52
9	9.780968	9.901488	9.879478	10.120522	51
10	9.781134	9.901391	9.879741	10.120259	50
11	9.781301	9.901298	9.880003	10.119997	49
12	9.781467	9.901202	9.880265	10.119734	48
13	9.781634	9.901106	9.880528	10.119472	47
14	9.781800	9.901010	9.880790	10.119210	46
15	9.781966	9.900914	9.881052	10.118948	45
16	9.782132	9.900828	9.881314	10.118686	44
17	9.782298	9.900722	9.881576	10.118424	43
18	9.782464	9.900626	9.881839	10.118161	42
19	9.782690	9.900529	9.882101	10.117899	41
20	9.782796	9.900433	9.882363	10.117637	40
21	9.782961	9.900337	9.882625	10.117375	39
22	9.783127	9.900240	9.882886	10.117114	38
23	9.783292	9.900144	9.883148	10.116852	37
24	9.783457	9.900047	9.883410	10.116590	36
25	9.783623	9.899951	9.883672	10.116328	35
26	9.783788	9.899854	9.883934	10.116066	34
27	9.783953	9.899757	9.884195	10.115805	33
28	9.784118	9.899660	9.884457	10.115543	32
29	9.784282	9.899563	9.884719	10.115281	31
30	9.784447	9.899467	9.884980	10.115020	30
	Co-sine	Sine	*Co-tang.*	Tangent	M

M	Sine	*Co-sine*	Tangent	*Co-tang.*	
30	9.784447	9.899467	9.884980	10.115025	30
31	9.784616	9.899370	9.885242	10.114758	29
32	9.784776	9.899273	9.885503	10.114497	28
33	9.784941	9.899175	9.885765	10.114235	27
34	9.785105	9.899078	9.886026	10.113974	26
35	9.785269	9.898981	9.886288	10.113712	25
36	9.785433	9.898884	9.886549	10.113451	24
37	9.785591	9.898787	9.886810	10.113190	23
38	9.785761	9.898689	9.887072	10.112928	22
39	9.785925	9.898592	9.887333	10.112667	21
40	9.786088	9.898494	9.887594	10.112406	20
41	9.786252	9.898397	9.887855	10.112145	19
42	9.786416	9.898299	9.888116	10.111884	18
43	9.786579	9.898201	9.888377	10.111623	17
44	9.786742	9.898104	9.888638	10.111362	16
45	9.786909	9.898006	9.888899	10.111101	15
46	9.787069	9.897908	9.889160	10.110840	14
47	9.787232	9.897810	9.889421	10.110579	13
48	9.787395	9.897112	9.889682	10.110318	12
49	9.787557	9.897614	9.889943	10.110057	11
50	9.787720	9.897516	9.890204	10.109796	10
51	9.787883	9.897418	9.890465	10.109535	9
52	9.788045	9.897320	9.890725	10.109275	8
53	9.788208	9.897222	9.890986	10.109014	7
54	9.788370	9.897123	9.891248	10.108753	6
55	9.788532	9.897025	9.891507	10.108493	5
56	9.788694	9.896926	9.891768	10.108232	4
57	9.788856	9.896828	9.892028	10.107972	3
58	9.789018	9.896729	9.892289	10.107711	2
59	9.789180	9.896631	9.892549	10.107451	1
60	9.789342	9.896532	9.892810	10.107190	0
	Co-sine	Sine	*Co-tang.*	Tangent	M

M	Sine	Co-sine		Tangent	Co-tang.	
0	9.789342	9.896532		9.892810	10.107190	60
1	9.789504	9.896433		9.893070	10.106930	59
2	9.789665	9.896335		9.893330	10.106669	58
3	9.789827	9.896236		9.893591	10.106409	57
4	9.789988	9.896137		9.893851	10.106149	56
5	9.790149	9.896038		9.894111	10.105889	55
6	9.790310	9.895939		9.894371	10.105628	54
7	9.790471	9.895840		9.894632	10.105368	53
8	9.790632	9.895741		9.894892	10.105108	52
9	9.790793	9.895641		9.895152	10.104844	51
10	9.790954	9.895542		9.895412	10.104588	50
11	9.791115	9.895443		9.895672	10.104328	49
12	9.791275	9.895343		9.895932	10.104068	48
13	9.791436	9.895244		9.896192	10.103808	47
14	9.791596	9.895144		9.896452	10.103548	46
15	9.791756	9.895045		9.896712	10.103288	45
16	9.791917	9.894945		9.896971	10.103028	44
17	9.792077	9.894846		9.897231	10.102769	43
18	9.792237	9.894746		9.897491	10.102509	42
19	9.792397	9.894646		9.897751	10.102249	41
20	9.792557	9.894546		9.898010	10.101990	40
21	9.792716	9.894446		9.898270	10.101730	39
22	9.792876	9.894346		9.898530	10.101470	38
23	9.793035	9.894246		9.898789	10.101211	37
24	9.793195	9.894146		9.899049	10.100951	36
25	9.793354	9.894046		9.899308	10.100692	35
26	9.793513	9.893946		9.899568	10.100432	34
27	9.793673	9.893845		9.899827	10.100173	33
28	9.793832	9.893745		9.900086	10.099913	32
29	9.793991	9.893645		9.900346	10.099654	31
30	9.794149	9.893544		9.900605	10.099395	30
	Co-sine	Sine		Co-tang.	Tangent	M

M	Sine	*Co-sine*	Tangent	*Co-tang.*	
30	9.794149	9.893544	9.900605	10.099395	30
31	9.794308	9.893444	9.900864	10.099135	29
32	9.794467	9.893343	9.901124	10.098876	28
33	9.794626	9.893243	9.901383	10.098617	27
34	9.794784	9.893142	9.901642	10.098358	26
35	9.794942	9.893041	9.901901	10.098099	25
36	9.795101	9.892940	9.902160	10.097839	24
37	9.795259	9.892839	9.902419	10.097580	23
38	9.795417	9.892738	9.902678	10.097321	22
39	9.795575	9.892637	9.902937	10.097062	21
40	9.795733	9.892536	9.903196	10.096803	20
41	9.795891	9.892435	9.903455	10.096544	19
42	9.796049	9.892334	9.903714	10.096285	18
43	9.796206	9.892233	9.903973	10.096027	17
44	9.796364	9.892132	9.904232	10.095768	16
45	9.796521	9.892030	9.904491	10.095509	15
46	9.796678	9.891929	9.904750	10.095250	14
47	9.796836	9.891827	9.905008	10.094991	13
48	9.796993	9.891726	9.905267	10.094733	12
49	9.797150	9.891624	9.905526	10.094474	11
50	9.797307	9.891522	9.905784	10.094215	10
51	9.797464	9.891421	9.906043	10.093957	9
52	9.797621	9.891319	9.906302	10.093698	8
53	9.797777	9.891217	9.906560	10.093440	7
54	9.797934	9.891115	9.906819	10.093181	6
55	9.798091	9.891013	9.907077	10.092923	5
56	9.798247	9.890911	9.907336	10.092664	4
57	9.798403	9.890809	9.907594	10.092406	3
58	9.798560	9.890707	9.907852	10.092147	2
59	9.798716	9.890605	9.908111	10.091889	1
60	9.798872	9.890503	9.908369	10.091631	0
	Co-sine.	Sine	*Co-tang.*	Tangent	M

Degree 51.

M	Sine	Co-sine	Tangent	Co-tang.	
0	9.798872	9.890503	9.908369	10.091631	60
1	9.799028	9.890400	9.908627	10.091373	59
2	9.799184	9.890298	9.908886	10.091114	58
3	9.799339	9.890195	9.909144	10.090856	57
4	9.799495	9.890093	9.909402	10.090598	56
5	9.799651	9.889990	9.909660	10.090340	55
6	9.799806	9.889888	9.909918	10.090081	54
7	9.799961	9.889785	9.910176	10.089823	53
8	9.800117	9.889682	9.910435	10.089565	52
9	9.800272	9.889579	9.910693	10.089307	51
10	9.800427	9.889476	9.910951	10.089049	50
11	9.800582	9.889374	9.911209	10.088791	49
12	9.800737	9.889271	9.911467	10.088533	48
13	9.800892	9.889167	9.911724	10.088275	47
14	9.801047	9.889064	9.911982	10.088017	46
15	9.801201	9.888961	9.912240	10.087760	45
16	9.801356	9.888858	9.912498	10.087502	44
17	9.801510	9.888755	9.912756	10.087244	43
18	9.801665	9.888651	9.913014	10.086986	42
19	9.801819	9.888548	9.913271	10.086729	41
20	9.801973	9.888444	9.913529	10.086471	40
21	9.802127	9.888341	9.913787	10.086213	39
22	9.802282	9.888237	9.914044	10.085956	38
23	9.802435	9.888133	9.914302	10.085698	37
24	9.802589	9.888030	9.914560	10.085440	36
25	9.802743	9.887926	9.914817	10.085183	35
26	9.802897	9.887822	9.915075	10.084925	34
27	9.803050	9.887718	9.915332	10.084668	33
28	9.803204	9.887614	9.915590	10.084410	32
29	9.803357	9.887510	9.915847	10.084153	31
30	9.803510	9.887406	9.916104	10.083895	30
	Co-sine.	Sine	*Co-tang.*	Tangent	M

M	Sine	Co-sine	Tangent	Co-tang.	
30	9.803510	9.887406	9.916104	10.083895	30
31	9.803664	9.887302	9.916362	10.083638	29
32	9.803817	9.887198	9.916619	10.083381	28
33	9.803970	9.887093	9.916876	10.083123	27
34	9.804123	9.887989	9.917134	10.082866	26
35	9.804276	9.886884	9.917391	10.082609	25
36	9.804428	9.886780	9.917648	10.082352	24
37	9.804581	9.886675	9.917905	10.082094	23
38	9.804734	9.886571	9.918162	10.081837	22
39	9.804886	9.886466	9.918420	10.081580	21
40	9.805038	9.886361	9.918677	10.081323	20
41	9.805191	9.886257	9.918934	10.081066	19
42	9.805343	9.886152	9.919191	10.080809	18
43	9.805495	9.886047	9.919448	10.080552	17
44	9.805647	9.885942	9.919705	10.080295	16
45	9.805799	9.885837	9.919962	10.080038	15
46	9.805951	9.885732	9.920219	10.079781	14
47	9.806103	9.885627	9.920476	10.079524	13
48	9.806254	9.885521	9.920733	10.079267	12
49	9.806406	9.885416	9.920990	10.079010	11
50	9.806557	9.885311	9.921247	10.078753	10
51	9.806709	9.885205	9.921503	10.078496	9
52	9.806860	9.885100	9.921760	10.078240	8
53	9.807011	9.884994	9.922017	10.077983	7
54	9.807162	9.884889	9.922274	10.077726	6
55	9.807314	9.884783	9.922530	10.077469	5
56	9.807464	9.884677	9.922787	10.077213	4
57	9.807615	9.884572	9.923044	10.076956	3
58	9.807766	9.884466	9.923300	10.076699	2
59	9.807917	9.884360	9.923557	10.076443	1
60	9.808067	9.884254	9.923813	10.076186	0
M	Co-sine	Sine	Co-tang.	Tangent	M

Degree 50.

M	Sine	Co-sine	Tangent	Co-tang.	
0	9.808067	9.884254	9.923813	10.076186	60
1	9.808218	9.884148	9.924070	10.075930	59
2	9.808368	9.884042	9.924327	10.075673	58
3	9.808519	9.883936	9.924583	10.075417	57
4	9.808669	9.883829	9.924839	10.075160	56
5	9.808819	9.883723	9.925096	10.074904	55
6	9.808969	9.883617	9.925352	10.074647	54
7	9.809119	9.883510	9.925609	10.074391	53
8	9.809269	9.883404	9.925865	10.074135	52
9	9.809419	9.883297	9.926121	10.073878	51
10	9.809569	9.883191	9.926378	10.073622	50
11	9.809718	9.883084	9.926634	10.073366	49
12	9.809868	9.882977	9.926890	10.073110	48
13	9.810017	9.882871	9.927147	10.072853	47
14	9.810166	9.882764	9.927403	10.072597	46
15	9.810316	9.882657	9.927659	10.072341	45
16	9.810465	9.882550	9.927915	10.072085	44
17	9.810614	9.882443	9.928171	10.071829	43
18	9.810763	9.882336	9.928427	10.071573	42
19	9.810912	9.882228	9.928683	10.071317	41
20	9.810061	9.882121	9.928940	10.071060	40
21	9.811210	9.882014	9.929196	10.070804	39
22	9.811358	9.881907	9.929452	10.070548	38
23	9.811506	9.881799	9.929708	10.070292	37
24	9.811655	9.881692	9.929964	10.070036	36
25	9.811804	9.881584	9.930219	10.069781	35
26	9.811952	9.881477	9.930475	10.069525	34
27	9.812100	9.881369	9.930731	10.069269	33
28	9.812248	9.881261	9.930987	10.069013	32
29	9.812396	9.881153	9.931243	10.068757	31
30	9.812544	9.881045	9.931499	10.068501	30
	Co-sine	Sine	Co-tang.	Tangent	M

Degree 55.

M	Sine	Co-sine	Tangent	Co-tang.	
30	9.812544	9.881045	9.931499	10.068501	30
31	9.812692	9.880937	9.931755	10.068245	29
32	9.812840	9.880829	9.932010	10.067989	28
33	9.812988	9.880721	9.932266	10.067734	27
34	9.813135	9.880613	9.932522	10.067478	26
35	9.813283	9.880505	9.932778	10.067222	25
36	9.813430	9.880397	9.933033	10.066967	24
37	9.813578	9.880289	9.933289	10.066711	23
38	9.813725	9.880180	9.933545	10.066455	22
39	9.813872	9.880072	9.933800	10.066200	21
40	9.814019	9.879963	9.934056	10.065944	20
41	9.814166	9.879855	9.934311	10.065688	19
42	9.814313	9.879746	9.934567	10.065433	18
43	9.814460	9.879637	9.934822	10.065177	17
44	9.814607	9.879529	9.935078	10.064922	16
45	9.814753	9.879420	9.935333	10.064666	15
46	9.814900	9.879311	9.935589	10.064411	14
47	9.815046	9.879202	9.935844	10.064156	13
48	9.815193	9.879093	9.936100	10.063900	12
49	9.815339	9.878984	9.936355	10.063645	11
50	9.815485	9.878875	9.936610	10.063389	10
51	9.815631	9.878766	9.936866	10.063134	9
52	9.815777	9.878656	9.937121	10.062879	8
53	9.815923	9.878547	9.937376	10.062623	7
54	9.816069	9.878438	9.937632	10.062368	6
55	9.816215	9.878328	9.937887	10.062113	5
56	9.816361	9.878219	9.938142	10.061858	4
57	9.816506	9.878109	9.938397	10.061602	3
58	9.816652	9.877999	9.938653	10.061347	2
59	9.816797	9.877890	9.938908	10.061092	1
60	9.816943	9.877780	9.939163	10.060837	0
	Co-sine	Sine	Co-tang.	Tangent	M

Degree 49.

M	Sine	Co-sine	Tangent	Co-tang.	
0	9.816943	9.877780	9.939163	10.060837	60
1	9.817088	9.877670	9.939418	10.060582	59
2	9.817233	9.877560	9.939673	10.06c327	58
3	9.817378	9.877450	9.939928	10.060072	57
4	9.817523	9.877340	9.940183	10.059816	56
5	9.817668	9.877230	9.940438	10.059562	55
6	9.817813	9.877120	9.940693	10.059307	54
7	9.817958	9.877009	9.940948	10.059052	53
8	9.818103	9.876899	9.941203	10.058797	52
9	9.818247	9.876789	9.941458	10.058542	51
10	9.818392	9.876678	9.941713	10.058287	50
11	9.818536	9.876568	9.941968	10.058032	49
12	9.818681	9.876457	9.942223	10.057777	48
13	9.818825	9.876347	9.942478	10.057522	47
14	9.818969	9.876236	9.942733	10.057267	46
15	9.818113	9.876125	9.942988	10.057012	45
16	9.819257	9.876014	9.943243	10.056757	44
17	9.819401	9.875904	9.943498	10.056502	43
18	9.819545	9.875793	9.943752	10.056248	42
19	9.819689	9.875682	9.944007	10.055993	41
20	9.819832	9.875571	9.944262	10.055728	40
21	9.819976	9.875459	9.944517	10.055483	39
22	9.820119	9.875348	9.944771	10.055229	38
23	9.820263	9.875237	9.945026	10.054974	37
24	9.820406	9.875125	9.945281	10.054719	36
25	9.820549	9.875014	9.945535	10.054464	35
26	9.820693	9.874903	9.945790	10.054210	34
27	9.820836	9.874791	9.946045	10.053955	33
28	9.820979	9.874679	9.946299	10.053701	32
29	9.821122	9.874568	9.946554	10.053446	31
30	9.821264	9.874456	9.946808	10.053192	30
	Co-sine	Sine	Co-tang.	Tangent	M

Degree 48.

M	Sine	Co-sine		Tangent	Co-tang.	
30	9.821264	9.874456		9.946808	10.053192	30
31	9.821407	9.874344		9.947063	10.052937	29
32	9.821550	9.874232		9.947317	10.052682	28
33	9.821692	9.874120		9.947572	10.052428	27
34	9.821835	9.874008		9.947826	10.052173	26
35	9.821977	9.873896		9.948081	10.051919	25
36	9.822120	9.873784		9.948335	10.051664	24
37	9.822262	9.873672		9.948590	10.051410	23
38	9.822404	9.873560		9.948844	10.051156	22
39	9.822546	9.873447		9.949099	10.050901	21
40	9.822688	9.873335		9.949353	10.050647	20
41	9.822830	9.873223		9.949607	10.050393	19
42	9.822972	9.873110		9.949862	10.050138	18
43	9.823114	9.872998		9.950116	10.049884	17
44	9.823255	9.872885		9.950370	10.049630	16
45	9.823397	9.872772		9.950625	10.049375	15
46	9.823538	9.872659		9.950879	10.049121	14
47	9.823680	9.872546		9.951133	10.048867	13
48	9.823821	9.872434		9.951388	10.048612	12
49	9.823962	9.872321		9.951642	10.048358	11
50	9.824104	9.872208		9.951896	10.048104	10
51	9.824245	9.872094		9.952150	10.047850	9
52	9.824386	9.871981		9.952404	10.047575	8
53	9.824527	9.871868		9.952659	10.047341	7
54	9.824667	9.871755		9.952913	10.047087	6
55	9.824808	9.871641		9.953167	10.046833	5
56	9.824949	9.871528		9.953421	10.046579	4
57	9.825090	9.871414		9.953675	10.046325	3
58	9.825230	9.871301		9.953929	10.046071	2
59	9.825370	9.871187		9.954183	10.045817	1
60	9.825511	9.871073		9.954437	10.045563	0
	Co-sine	Sine		Co-tang.	Tangent	M

Degree 48.

M	Sine	Co-sine	Tangent	Co-tang.	
0	9.825511	9.871073	9.954437	10.045562	60
1	9.825651	9.870960	9.954691	10.045308	59
2	9.825791	9.870846	9.954945	10.045054	58
3	9.825931	9.870732	9.955199	10.044800	57
4	9.826071	9.870618	9.955453	10.044546	56
5	9.826211	9.870504	9.955707	10.044292	55
6	9.826351	9.870390	9.955961	10.043038	54
7	9.826491	9.870275	9.956215	10.043784	53
8	9.826631	9.870161	9.956469	10.043531	52
9	9.826770	9.870047	9.956723	10.043276	51
10	9.826910	9.869933	9.956977	10.043023	50
11	9.827049	9.869818	9.957231	10.042769	49
12	9.827189	9.869704	9.957485	10.042515	48
13	9.827328	9.869589	9.957739	10.042261	47
14	9.827467	9.869474	9.957993	10.042007	46
15	9.827606	9.869360	9.958246	10.041753	45
16	9.827745	9.869245	9.958500	10.041500	44
17	9.827884	9.869130	9.958754	10.041246	43
18	9.828023	9.869015	9.959008	10.040992	42
19	9.828162	9.868900	9.959262	10.040738	41
20	9.828301	9.868785	9.959515	10.040485	40
21	9.828439	9.868670	9.959769	10.040231	39
22	9.828578	9.868555	9.960023	10.039977	38
23	9.828716	9.868439	9.960277	10.039723	37
24	9.828855	9.868324	9.960530	10.039469	36
25	9.828993	9.868209	9.960784	10.039216	35
26	9.829131	9.868093	9.961038	10.038962	34
27	9.829269	9.867978	9.961291	10.038608	33
28	9.829407	9.867862	9.961545	10.038451	32
29	9.829545	9.867747	9.961799	10.038201	31
30	9.829683	9.867631	9.962052	10.037947	30
	Co-sine	Sine	Co-tang.	Tangent	M

Degree 47.

M	Sine	Co-sine	Tangent	Co-tang.	
30	9.829683	9.867631	9.962052	10.037947	30
31	9.829821	9.867515	9.962306	10.037694	29
32	9.829959	9.867399	9.962560	10.037440	28
33	9.830096	9.867283	9.962813	10.037187	27
34	9.830234	9.867167	9.963067	10.036933	26
35	9.830372	9.867051	9.963320	10.036680	25
36	9.830509	9.866935	9.963574	10.036426	24
37	9.830646	9.866819	9.963827	10.036173	23
38	7.830784	9.866703	9.964081	10.035919	22
39	9.830921	9.866586	9.964335	10.035665	21
40	9.831058	9.866470	9.964588	10.035412	20
41	9.831195	9.866353	9.964842	10.035158	19
42	9.831332	9.866237	9.965095	10.034905	18
43	9.831469	9.866120	9.965348	10.034652	17
44	9.831606	9.866004	9.965602	10.034398	16
45	9.831742	9.865887	9.965855	10.034144	15
46	9.831879	9.865770	9.966109	10.033891	14
47	9.832015	9.865653	9.966362	10.033638	13
48	9.832152	9.865536	9.966616	10.033384	12
49	9.832288	9.865419	9.966869	10.033131	11
50	9.832425	9.865302	9.967122	10.032878	10
51	9.832561	9.865185	9.967376	10.032624	9
52	9.832697	9.865068	9.967629	10.032371	8
53	9.832833	9.864950	9.967883	10.032117	7
54	9.832969	9.864833	9.968136	10.031864	6
55	9.833105	9.864716	9.968389	10.031611	5
56	9.833241	9.864598	9.968643	10.031357	4
57	9.833376	9.864480	9.968896	10.031104	3
58	9.833512	9.864363	9.969149	10.030851	2
59	9.833648	9.864245	9.969403	10.030597	1
60	9.833783	9.864127	9.969656	10.030344	0
	Co-sine.	Sine	Co-tang.	Tangent	M

Degree 47.

M	Sine	*Co-sine*	Tangent	*Co-tang.*	
0	9.833783	9.864127	9.969656	10.030344	60
1	9.833919	9.864010	9.969909	10.030091	59
2	9.834054	9.863892	9.970162	10.029838	58
3	9.834189	9.863774	9.970416	10.029584	57
4	9.834324	9.863656	9.970669	10.029331	56
5	9.834460	9.863537	9.970922	10.029078	55
6	9.834595	9.863419	9.971175	10.028827	54
7	9.834730	9.863301	9.971428	10.028571	53
8	9.834865	9.863183	9.971682	10.028318	52
9	9.834999	9.863064	9.971935	10.028065	51
10	9.835134	9.862946	9.972188	10.027812	50
11	9.835269	9.862827	9.972441	10.027559	49
12	9.835503	9.862709	9.972694	10.027306	48
13	9.835538	9.862590	9.972948	10.027052	47
14	9.835672	9.862471	9.973201	10.026799	46
15	9.835806	9.862353	9.973454	10.026546	45
16	9.835941	9.862234	9.973707	10.026293	44
17	9.836075	9.862115	9.973960	10.026040	43
18	9.836209	9.861996	9.974213	10.025787	42
19	9.836343	9.861877	9.974466	10.025533	41
20	9.836477	9.861757	9.974719	10.025280	40
21	9.836611	9.861638	9.974973	10.025027	39
22	9.836745	9.861519	9.975229	10.024774	38
23	9.836878	9.861399	9.975479	10.024521	37
24	9.837012	9.861280	9.975732	10.024268	36
25	9.837146	9.861161	9.975985	10.024015	35
26	9.837279	9.861041	9.976238	10.023762	34
27	9.837412	9.860921	9.976491	10.023509	33
28	9.837546	9.860802	9.976744	10.023256	32
29	9.837679	9.860682	9.976997	10.023003	31
30	9.837812	9.860562	9.977250	10.022750	30
	Co-sine.	Sine	*Co-tang.*	Tangent	M

M	Sine	Co-sine	Tangent	Co-tang.	
30	9.837812	9.860562	9.977250	10.022750	30
31	9.837945	9.860442	9.977503	10.022497	29
32	9.838078	9.860322	9.977756	10.022244	28
33	9.838211	9.860202	9.978009	10.021991	27
34	9.838344	9.860082	9.978262	10.021738	26
35	9.838477	9.859962	9.978515	10.021485	25
36	9.838009	9.859842	9.978768	10.021232	24
37	9.838742	9.859721	9.979021	10.020979	23
38	9.838875	9.859601	9.979274	10.020726	22
39	9.839007	9.859480	9.979527	10.020473	21
40	9.839140	9.859360	9.979780	10.020220	20
41	9.839272	9.859239	9.980033	10.019967	19
42	9.839484	9.859118	9.980285	10.019714	18
43	9.839536	9.858998	9.980538	10.019461	17
44	9.839668	9.858877	9.980791	10.019209	16
45	9.839800	9.858756	9.981044	10.018956	15
46	9.839932	9.858639	9.981297	10.018703	14
47	9.840064	9.858514	9.981550	10.018450	13
48	9.840196	9.858398	9.981803	10.018197	12
49	9.840428	9.858272	9.982056	10.017944	11
50	9.840459	9.858150	9.982309	10.017691	10
51	9.840591	9.858029	9.982562	10.017438	9
52	9.840722	9.857908	9.982814	10.017185	8
53	9.840854	9.857786	9.983067	10.016933	7
54	9.840985	9.857665	9.983320	10.016683	6
55	9.841116	9.857543	9.983573	10.016427	5
56	9.841247	9.857421	9.983826	10.016174	4
57	9.841378	9.857300	9.984079	10.015921	3
58	9.841509	9.857178	9.984331	10.015668	2
59	9.841640	9.857056	9.984584	10.015416	1
60	9.841771	9.856934	9.984837	10.015163	0
	Co-sine	Sine	Co-tang.	Tangent	M

M	Sine	*Co-sine*	Tangent	*Co-tang.*	
0	9.841771	9.856934	9.984837	10.015162	60
1	9.841902	9.856812	9.985090	10.014910	59
2	9.842033	9.856690	9.985343	10.014657	58
3	9.842163	9.856568	9.985596	10.014404	57
4	9.842294	9.856445	9.985848	10.014151	56
5	9.842424	9.856323	9.986101	10.013899	55
6	9.842555	9.856201	9.986354	10.013646	54
7	9.842685	9.856078	9.986607	10.013393	53
8	9.842815	9.855956	9.986859	10.013140	52
9	9.842945	9.855833	9.987112	10.012888	51
10	9.843076	9.855710	9.987365	10.012635	50
11	9.843206	9.855588	9.987618	10.012382	49
12	9.843336	9.855465	9.987871	10.012129	48
13	9.843465	9.855342	9.988123	10.011877	47
14	9.843595	9.855219	9.988376	10.011624	46
15	9.843725	9.855096	9.988629	10.011371	45
16	9.843855	9.854973	9.988882	10.011118	44
17	9.843984	9.854850	9.989134	10.010866	43
18	9.844114	9.854727	9.989387	10.010613	42
19	9.844243	9.854603	9.989640	10.010360	41
20	9.844372	9.854480	9.989893	10.010107	40
21	9.844502	9.854356	9.990145	10.009855	39
22	9.844631	9.854233	9.990398	10.009602	38
23	9.844760	9.854109	9.990651	10.009349	37
24	9.844889	9.853986	9.990903	10.009096	36
25	9.845018	9.853862	9.991156	10.008844	35
26	9.845147	9.853738	9.991409	10.008591	34
27	9.845276	9.853614	9.991662	10.008338	33
28	9.845404	9.853490	9.991914	10.008086	32
29	9.845533	9.853366	9.992167	10.007833	31
30	9.845662	9.853242	9.992420	10.007580	30
	Co-sine	Sine	*Co-tang.*	Tangent	M

Degree 45.

M	Sine	Co-fine	Tangent	Co-tang.	
30	9.845662	9.853242	9.992420	10.007580	30
31	9.845790	9.853118	9.992672	10.007328	29
32	9.845919	9.852994	9.992925	10.007075	28
33	9.846047	9.852869	9.993178	10.006822	27
34	9.846175	9.852745	9.993430	10.006569	26
35	9.846304	9.852620	9.993683	10.006317	25
36	9.846432	9.852496	9.993936	10.006064	24
37	9.846560	9.852371	9.994189	10.005811	23
38	9.846688	9.852246	9.994441	10.005559	22
39	9.846816	9.852122	9.994694	10.005306	21
40	9.846944	9.851997	9.994947	10.005053	20
41	9.847071	9.851872	9.995199	10.004801	19
42	9.847199	9.851747	9.995452	10.004548	18
43	9.847327	9.851622	9.995701	10.004295	17
44	9.847454	9.851497	9.995957	10.004043	16
45	9.847582	9.851372	9.996210	10.003790	15
46	9.847709	9.851246	9.996463	10.003537	14
47	9.847836	9.851121	9.996715	10.003285	13
48	9.847964	9.850996	9.996968	10.003032	12
49	9.848091	9.850870	9.997220	10.002779	11
50	9.848218	9.850745	9.997473	10.002527	10
51	9.848345	9.850619	9.997726	10.002274	9
52	9.848472	9.850493	9.997979	10.002021	8
53	9.848599	9.850367	9.998231	10.001769	7
54	9.848726	9.850242	9.998484	10.001516	6
55	9.848852	9.850116	9.998737	10.001263	5
56	9.848979	9.849990	9.998989	10.001011	4
57	9.849106	9.849864	9.999242	10.001758	3
58	9.849232	9.849737	9.999495	10.000505	2
59	9.849359	9.849611	9.999747	10.000253	1
60	9.849485	9.849485	10.000000	10.000000	0
	Co-fine	Sine	Co-tang.	Tangent	M

Degree 45.

F I N I S.

Some Books ſold by W. Freeman *at the* Artichoke *next St.* Dunſtan'*s Church in* Fleet-ſtreet.

REports in the Court of King's-Bench from the 12*th.* to the 30*th.* Year of the Reign of our late Sovereign Lord King *Charles* II. in 3 Vol. Taken by *J. Keble* of *Grey's-Inn*, Eſquire; with new and uſefull Tables to all the 3 Vol.

Sheppard's Preſident of Preſidents. 8°.

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The Inſtitution and Life of *Cyrus* the Great, written by the famous Philoſopher and General, *Zenophon* of *Athens*. Tranſlated by *F. Digby* and *J. Norris*.

Holy Devotions with Directions to Pray: Alſo a Brief Expoſition on the Lord's Prayer, Creed, Ten Commandments, ſeven Penitential Pſalms, and the ſeven Pſalms of Thankſgiving, by the Right Reverend Father in God *Lancelot Andrews* late Biſhop of *Winchester*.

Daily Exerciſe for a Chriſtian, or a Manual of Private Devotions, as well for every day in the Week, as upon Particular Occaſions, by *J. Bridal*, Senior, Eſq; late of the Rolls.

A New Years Gift compoſed of Prayers and Meditations with Devotions for ſeveral Occaſions; the whole ſix parts compleat.

The

The *Old Religion*: A Treatiſe wherein is laid down the true State of the Difference betwixt the *Reformed* and *Roman Church*. Serving *for the Vindication of Our Innocence, for the ſetling of Wavering Minds, for a Preſervation againſt Popiſh Inſinuations*. By the Reverend Father in God *Joſ. Hall* late Lord Biſhop of *Exceſter*, and afterwards of *Norwich*.

The *Manners of the Iſraelites in* 3 parts. 1. Of the *Patriarchs*. 2. Of the *Iſraelites*, after their coming out of *Egypt*, untill the *Captivity* of *Babylon*. 3. Of the *Jews*, after their Return from the Captivity, untill the Preaching of the Goſpel, in 12°.

The *Means to preſerve Peace in Marriage*; being an ingenious Treatiſe written (Originally in *French*) by the Authour of the *Rules* of *Civility*.

The Penitent Pardoned, or a Diſcourſe of the Nature of Sin and Efficacy of Repentance, under the Parable of the Prodigal Son, by Dr. *Goodman*.

An infallible way to Contentment in the midſt of Publick and Perſonal Calamities, together with the Chriſtians Courage and Encouragement againſt evil Tidings and the fear of Death.

Argalus and *Parthenia*, by *F. Quarles*.
Nanis Hiſtory of *Venice*, Fol.
Hiſtory of the Government of *Venice*, 8°.
Policy of the *Venetians*, 12°.
The Miſtaken Beauty, a Comedy.
The Dutcheſs of *Malphey*.
The Empreſs of *Morocco*, a Farce.
The Court of the Gentiles in 4 parts compleat, by *Theophilus Gale*.